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ANNALS of SURGERY

VOL. LXXXIV JULY, 1926 No. 1

THE TREATMENT OF CUTANEOUS BURNS*

BY FREDERIC W. BANCROFT, M.D.
AND
CHARLES S. ROGERS, M.D.
OF NEW YORK, N. Y.

THE disappearance of the gas and kerosene lamp has not diminished the number of burns brought for treatment to metropolitan hospitals to the degree that one might expect. Lighted Christmas trees, gas stoves, exploding stills, boiling water, automobile and industrial injuries produce still an astounding number of burns. The toll from these injuries remains depressingly high—deaths, immediate and delayed are too frequent.

All surgeons must eventually appreciate the economic loss through prolonged hospital stay. This loss is borne not only by the patient, but also by the public for rarely does a ward patient pay his per capita expense to the hospital.

TABLE I.

Total number of cases		104
Deaths	Early, within 24 to 36 hours... 13	30
	Late 17	
Percentage Mortality		28%

Age Incidence of Burns

Decades	1	2	3	4	5	6	7	8
No. cases	36	9	17	20	11	7	1	3
Per cent	34	8	16	19	10	6	—1	2

Age Incidence of Deaths

Decades	1	2	3	4	5	6	7	8
Early	8	0	1	1				3
Late	6	0	1	3	4	2	1	
Total	14	0	2	4	4	2	1	3
Per cent	46⅔	0	6⅔	13⅓	13⅓	6⅔	3⅓	10

Comment Table I.—The high incidence and mortality of children under

Read before the American Surgical Association, May 26, 1926.

10 years should be impressed upon the public to stimulate education of mother and child.

Our figures show an instance of 34 per cent. burns in children under ten years of age. Deformities occurring at this age may result in their being public charges for many years. The memory of a burned child remains with the surgeon not only during the day, but often if he chances to lie awake at night, it may haunt him, particularly if he has a guilty feeling that at some time in the course of the treatment he might have done more to improve the child's condition. We feel that much must be done by public education

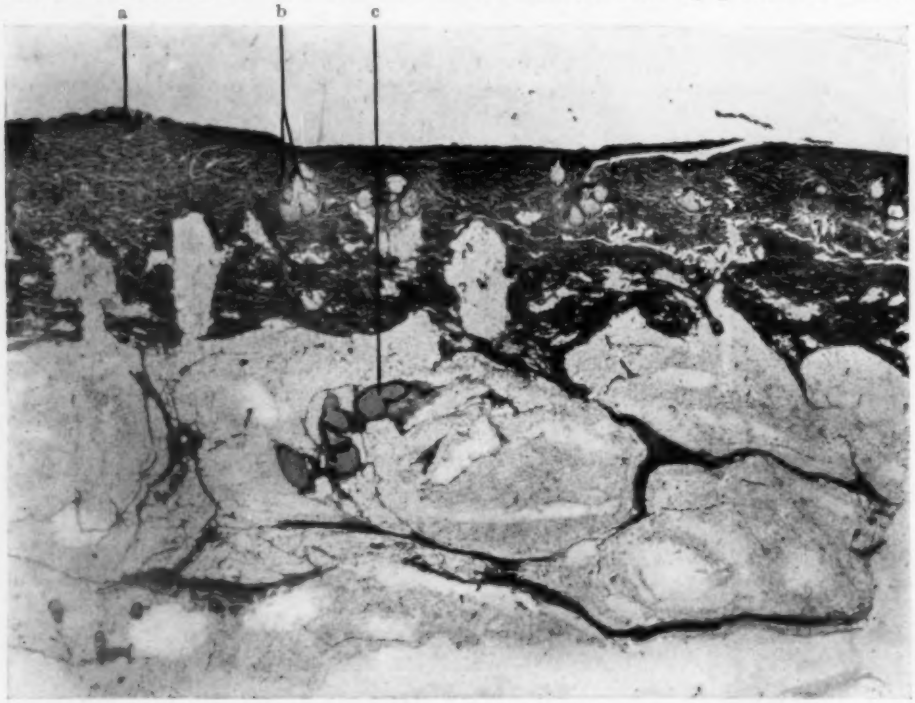

FIG. 1.—Case I. Low powered view débrided subcutaneous tissue and fat, two days after burn. a. Remnant of epithelium. b. Hair follicle and sebaceous glands. c. Blood-vessels.

both of mother and child to prevent this appalling percentage of burns in children.

As one reviews the literature, one sees that the pendulum of interest in these deplorable accidents of civilization swings as it does elsewhere in medicine. At times surgeons are stimulated to extreme interest, and this is reflected in the literature. Too often there is a lack of interest and these unfortunate patients are delegated to the most inexperienced house officer to dress and care for. No patient needs more painstaking care, day in and day out, unfortunately even month in and month out. Their treatment demands a knowledge of blood chemistry and often clear, sane surgical judgment. Dr. John Staige Davis has said that each extensively burned child needs to have not one, but twenty varieties of treatment, of operative procedures, of forms of skin grafts, and that no one rule can fit all burns; no, not even a single

large burn. But if a single rule should be followed, the only one is the use of extreme patience and constant reorganization of therapy.

Our purpose in presenting this paper is to offer nothing new, but to review the work of others—present some of the problems and pitfalls that have occurred during the treatment of a fairly large number of burns that have been admitted to the Lincoln Hospital during the past two and one-half years. We, at first, used the débridement method and lately have used tannic

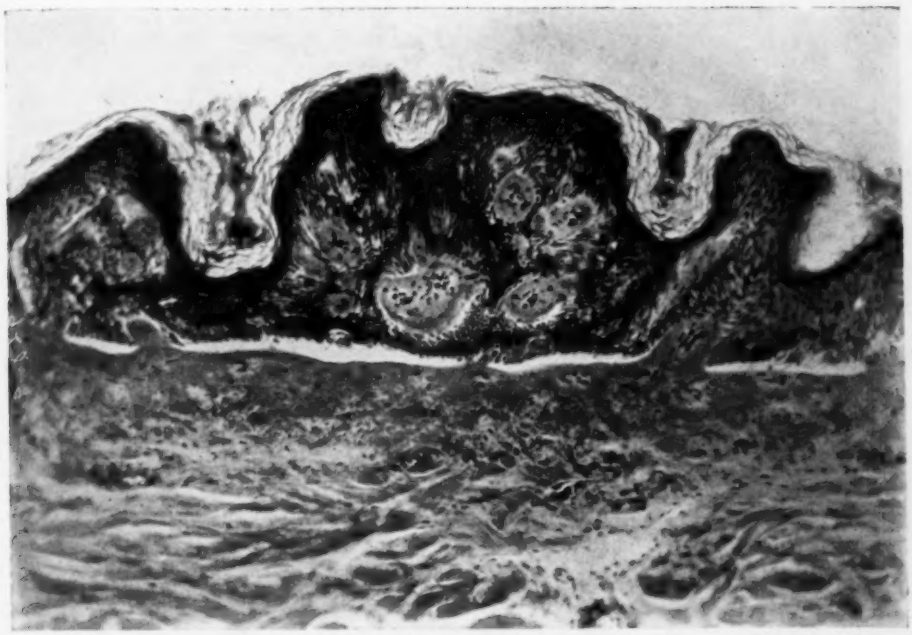

FIG. 2.—Case I. Remnant of epithelium showing epithelial pearls, injury to epithelium, œdema and granular degeneration of connective tissue.

acid. We have had opportunity to observe results from both methods and desire to offer our conclusions.

Burns are usually described as first, second and third degree. We believe that from a therapeutic point of view the present third degree burns should be divided into third and fourth degree.

Third degree burns are those that destroy the epithelium but do not destroy the hair follicles.

Fourth degree burns are those wherein all the epithelium and the subcutaneous fat is necrosed.

It is obvious in this classification that during repairs, islands of epithelium might arise from the epithelium of hair follicles in third degree burns, which would be absent in fourth degree burns. The importance of this differentiation will be brought out in the discussion of débridement of the necrosed tissue.

Death due to burns may be classed under two headings: (1) Shock. (2) Toxæmia.

1. In this group are cases dying within 24 to 36 hours with symptoms of

so-called shock, as evidenced by rapid pulse of low volume, coma or only partial consciousness, and subnormal temperature with a cold clammy skin.

On admission morphine is given immediately. External heat in the form of hot water bottles is applied wherever possible. In other cases the electric cradle is used. The administration of fluid has its part in the treatment of shock. Hypodermoclyses are given at repeated intervals and the Murphy drip is also made use of. We believe that one of the most important measures that should be used is early blood transfusion. This is to be done as near to

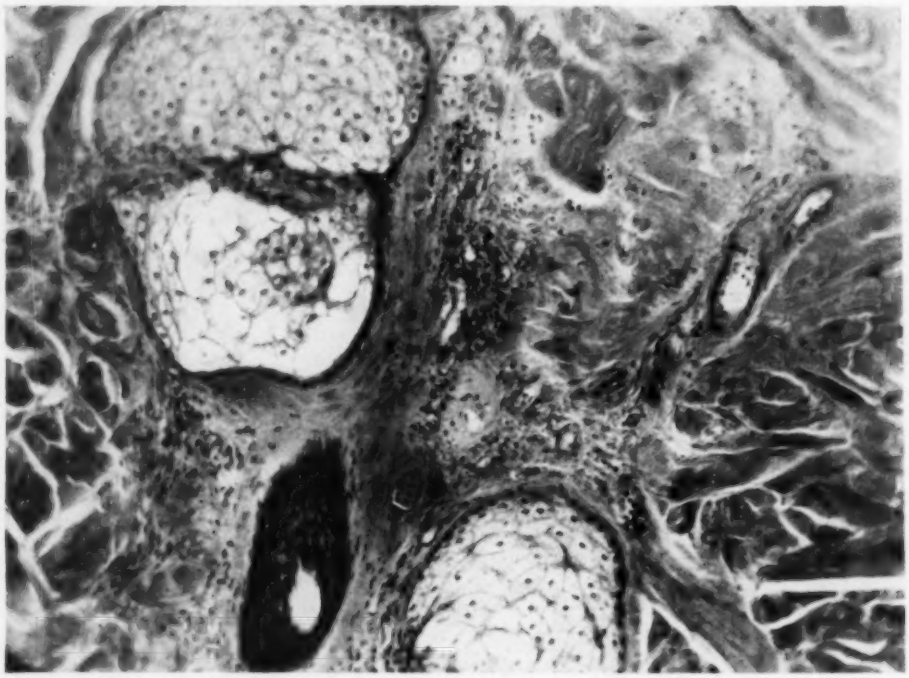

FIG. 3.—Case I. Hair follicle and sebaceous gland. Hair follicle with fairly normal appearing epithelium. Granular degeneration of connective tissue, polymorphonuclear and mononuclear infiltration.

the time of injury as possible, since its value is inversely proportional to the length of time that elapses between the injury and its administration. This last measure will often balance the scale in favor of a border-line case.

Where it is impossible to obtain a donor for transfusion, or the facilities are not adequate, glucose intravenously is of great assistance.

2. Numerous theories have been advanced to account for the deaths of patients dying from eight days to three weeks with symptoms suggesting toxæmia. Early writers thought this was due to interference with the skin functions and offered as examples the death of gilded experimental animals, but later evidence showed that these deaths were due to metallic poisoning. Robertson and Boyd burned the skin of young rabbits with hot metal plates. In one series of experiments the burned skin was removed within eight hours and grafted on unburned rabbits while the skin of the unburned rabbits was grafted to fill the defect of the burned. Their result showed development of

toxæmia in the rabbits receiving the burned transplants while the others escaped. If the transplants were made after eight hours both burned and unburned suffered. Robertson and Boyd further showed that the serum of burned children when injected into rabbits was innocuous. The injection of citrated whole blood caused typical toxæmia. Their conclusions were as follows: Toxic substances consist of two portions—one of which is thermosable, diffusable and neurotoxic; the other is thermolable, colloidal and necrotonic. Chemically, the toxin consists of primary and secondary proteoses.

Underhill and his co-workers found a marked concentration of the

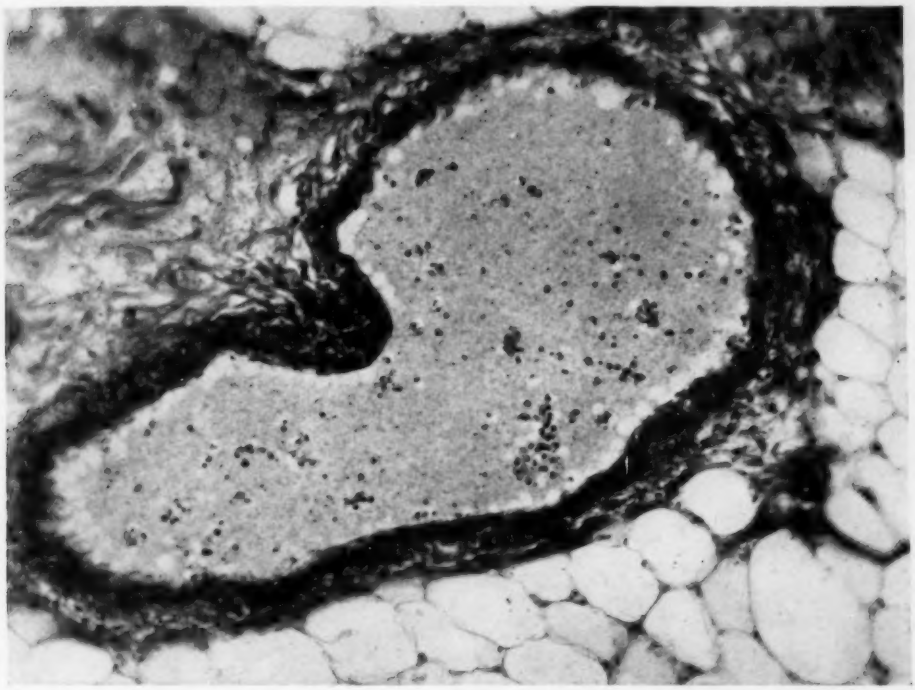

FIG. 4.—Case I. Blood-vessels with walls markedly traumatized and apparently coagulative necrosis of the blood.

blood in a study of 21 cases—the hæmoglobin in the serious cases varied from 150 to 209 per cent. of normal. Underhill concludes as follows: "Marked concentration of blood means a failing circulation, an inefficient oxygen carrier, oxygen starvation of the tissues, fall of temperature and finally suspension of vital activities." Similar conditions are found in war gases and in certain cases of influenza. He thinks this concentration is due to the constant pouring out of fluids on the burned surfaces. He believes an animal cannot long stand a concentration of 140 per cent. of normal value. Where the blood has been concentrated the sodium chloride content of the blood is low. In other words, the sodium chloride content varies inversely as the hæmoglobin.

Davidson, in a recent paper read before the Surgical Section of the New York Academy of Medicine, reported similar findings of sodium chloride

depletion and suggested the analogy between the toxæmia of intestinal obstruction and burns.

Davidson says " a third group of twelve patients was investigated in which the burned area varied in extent from one thousand square centimetres to 24 per cent. of the total body surface. In these cases the blood chlorides remained at a very low level as long as sloughs were present. Upon separation of the devitalized tissue, when absorption was no longer taking place, the blood chlorides rose, and a parallel rise of the urinary chlorides was noted.

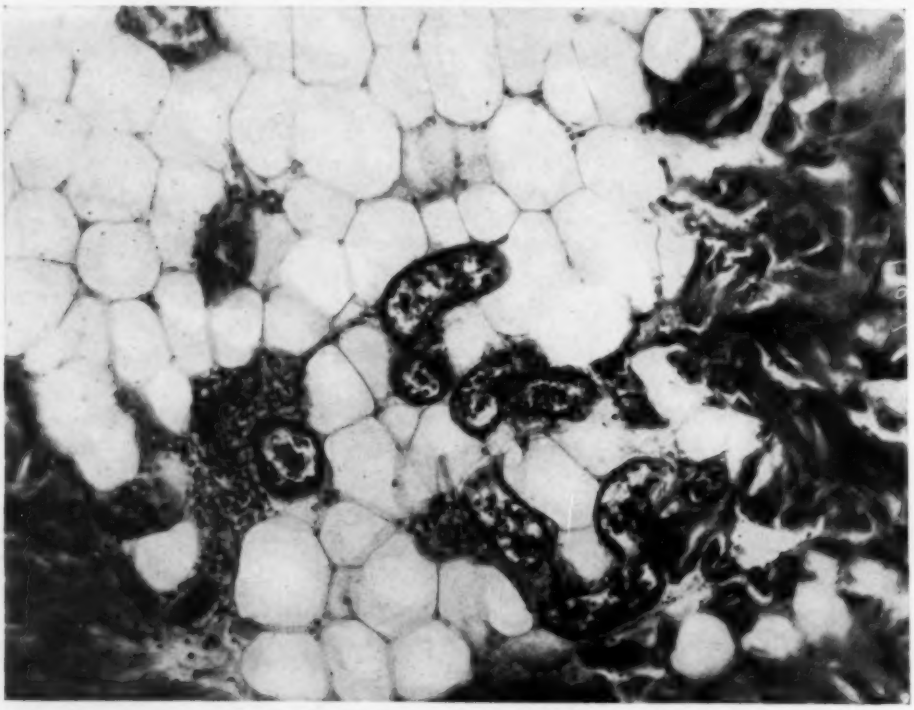

FIG. 5.—Case I. Shows an epithelial destruction of sweat glands and a granular degeneration of connective tissue.

The depressed values of the blood chlorides could not be attributed to diet, blood concentration, altered renal threshold, fever, nor to loss of plasma from the burned surfaces. The evidence suggested that there was retention of sodium chloride in the tissues in general quite similar to that observed in pneumonia."

" In view of these findings it would seem rational to correct this metabolic deficiency by the administration of sodium chloride. Further studies are necessary to determine whether sodium chloride will spare body protein similar to that observed by Haden and Orr in intestinal obstruction."

If we assume that the late deaths in burns are due to a toxæmia liberated by the injury, our treatment must be based, first to combat the toxæmia; second, to prevent as far as possible the absorption of the toxins into the blood stream.

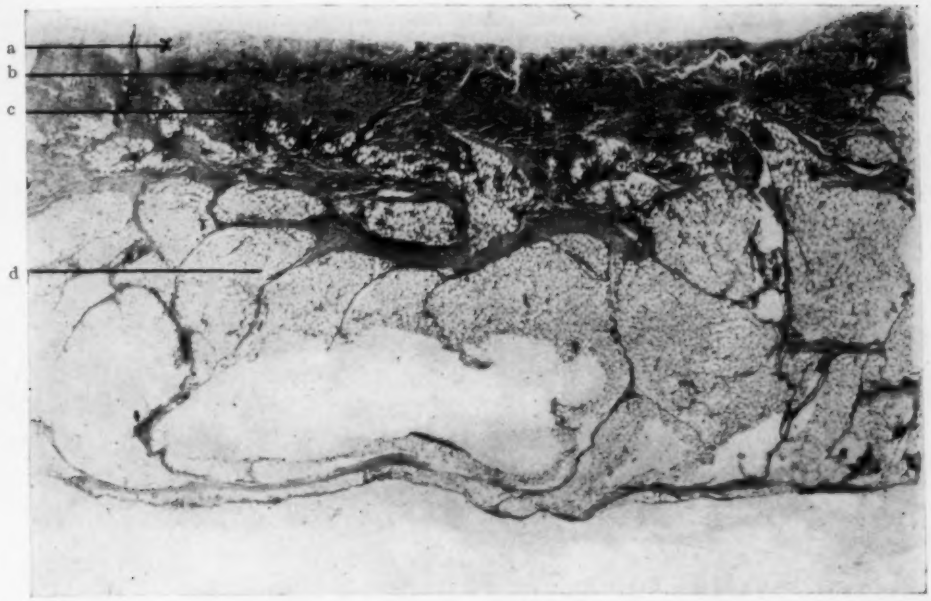

FIG. 6.—Case II. Low powered view, débridement six days after burn. a. Necrotic tissue. b. Separation zone. c. Living connective tissue. d. Fat.

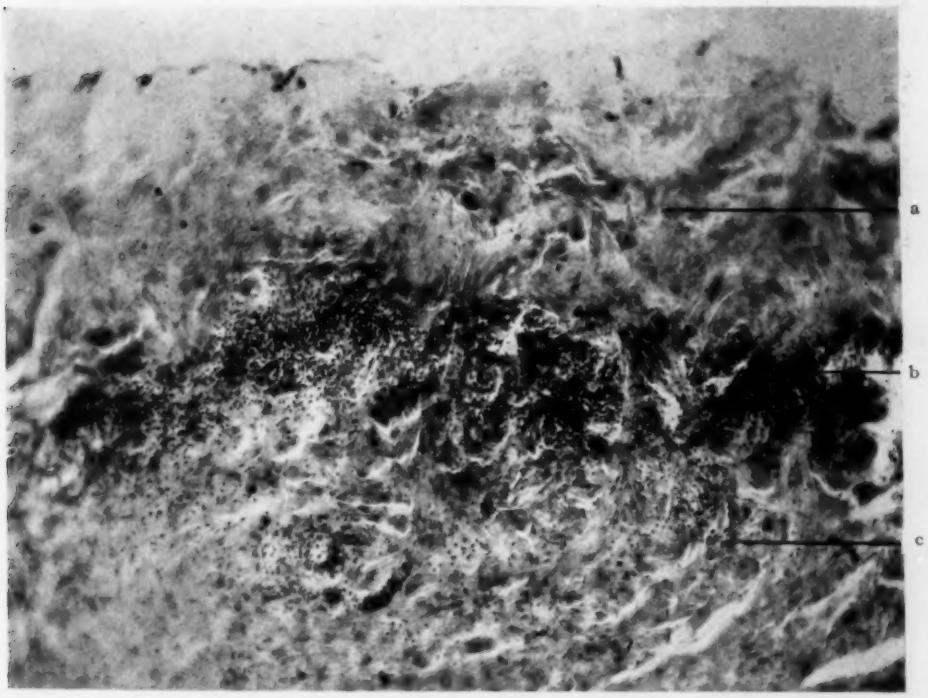

FIG. 7.—Case II. High powered view of separation zone. a. Necrosed tissue. b. Separation zone. c. Connective tissue showing presence of infection.

1. *Treatment of Toxæmia.*—In a great measure, the treatment of toxæmia is similar to that of shock, save that it must be continued over a longer period of time. Great emphasis is placed on fluid administration and the elimination of waste products. Again hypodermoclysis and fluids by mouth are forced. Attention should be paid to the local skin condition from which the absorption of large amounts of toxins takes place, unless the toxin material is either removed by débridement or taken care of by other measures.

It is vital that secretion which is profuse from the granulating surfaces be removed carefully and painstakingly to prevent severe infection. One

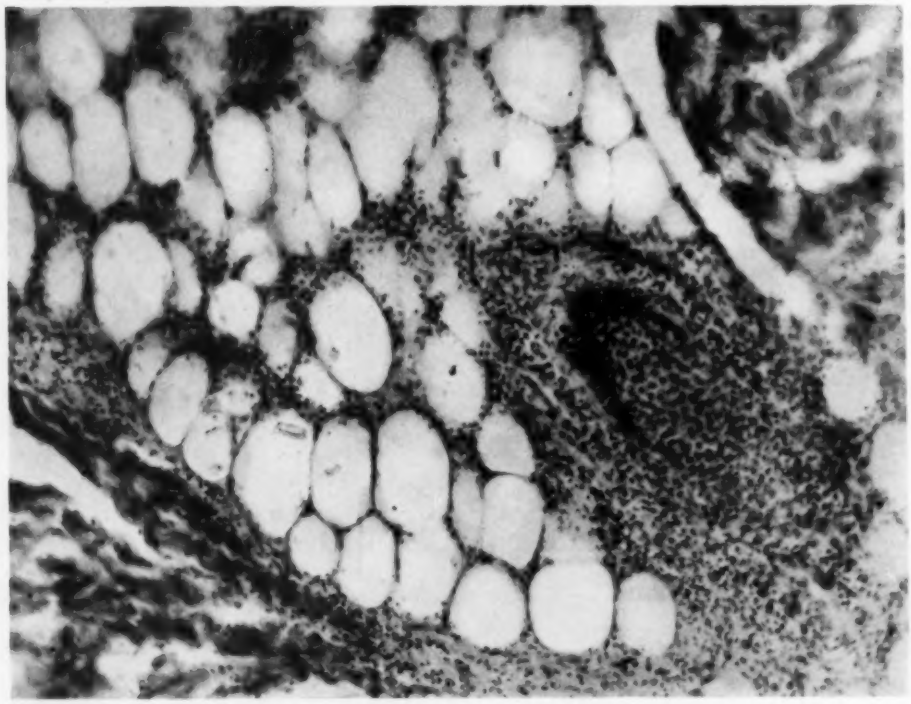

FIG. 8.—Case II. Shows an infection of fat and hair follicles.

very great factor in the prevention of these surface secretions after the sloughs have separated is early skin grafting.

As these patients go on from week to week, they develop a more or less severe secondary anæmia. There is a persistent temperature due to slow absorption of toxic products. For them the greatest benefit is to be derived from blood transfusion. Its value cannot be overestimated. This should be done as often as necessary, until the patient can carry on alone.

Ex sanguine transfusion has been advocated, but it seems to us a very heroic procedure. Accidents might happen during the transfusion necessitating its discontinuance. Furthermore, it can only be of very transient benefit as toxins are being constantly poured into the blood stream.

The necessity of fluid intake, often by means of hypodermoclysis, is

shown in one of our cases. A woman, thirty-two years of age, was admitted April 1, 1926. Her clothes had caught fire while reading in candle-light and she had extensive second and third degree burns of abdomen, chest, buttocks and thighs. She was treated by tannic acid for twenty-four hours. Two days after admission she was vomiting persistently. On the second day she was given 3000 c.c. by hypodermoclysis and on the third 2000 c.c. After the first hypodermoclysis her vomiting ceased. Four days later she again started vomiting but was immediately relieved by hypodermoclysis.

2. *Treatment of Local Condition.*—We at first attempted the débridement method as advised by Brager, Lieber and Willis. Efforts were made to see if we could determine on admission the line of demarcation between the second and third degree burns. This proved very difficult, so we waited until about the third day, when the patient was taken to the operating room, anæsthetized, and the area cleansed thoroughly. The skin and fat were then débrided frequently to the fascia. The fat seemed to us to be very severely damaged. It did not bleed actively and had a peculiar yellow-gray appearance. Whenever possible and necessary, the patient was transfused at the same time. Very frequently marked general improvement was noted in a few hours—as evidenced by improvement in the pulse—temperature and mental attitude. The wound was treated post-operatively with vaseline gauze.

TABLE II.
Cases Treated by Débridement

Total number of cases	7
Cases improved or cured	3
Cases that died	4
Average length hospital stay (all cases)	92 days
1 case still in hospital	126 days
Mortality	57%

The following two cases were cited as showing the marked immediate improvement following débridement:

CASE I.—V. K. A girl twelve years, admitted January 1, 1925 with severe second and third degree hot water burns over the buttocks, thighs, legs, feet and left hand. On her sixth day she was intensely toxic and was so ill that we doubted if she would live twenty-four hours. Under light anæsthesia the typical pig skin appearing burnt area down to fascia was completely removed from the right thigh and leg—a similar procedure was attempted on the left leg, but her condition was so serious that in many places the area was rapidly incised to the fascia by gridiron-like incisions. This was followed by a transfusion of 250 c.c. The next day her condition was markedly improved, and signs of toxæmia gradually disappeared. She progressed to a complete recovery.

CASE II.—E. B. Age fifty, admitted October 20, 1925. A very obese woman had extensive deep burns of back from the neck and dorsal surface of her arms to below the scapulæ—she was semi-stuporous on admission. The following day she was delirious with a rapid pulse and temperature of 103. She looked as if death were imminent. A

débridement of an area 8 x 10 inches was rapidly performed. The skin resembled parchment. She was immediately transfused with 450 c.c. whole blood. The improvement was startling. On the following day she was conscious, pulse was about 90—of good quality. Her condition remained excellent until about the twelfth day when her temperature became elevated and she died on her twenty-first day with symptoms suggesting infection although the wound appeared relatively clean.

We believe that both of these cases would have died immediately had not the toxic tissue been removed or the lymphatics and capillaries blocked by some chemical agent such as tannic acid. The last case was a very poor

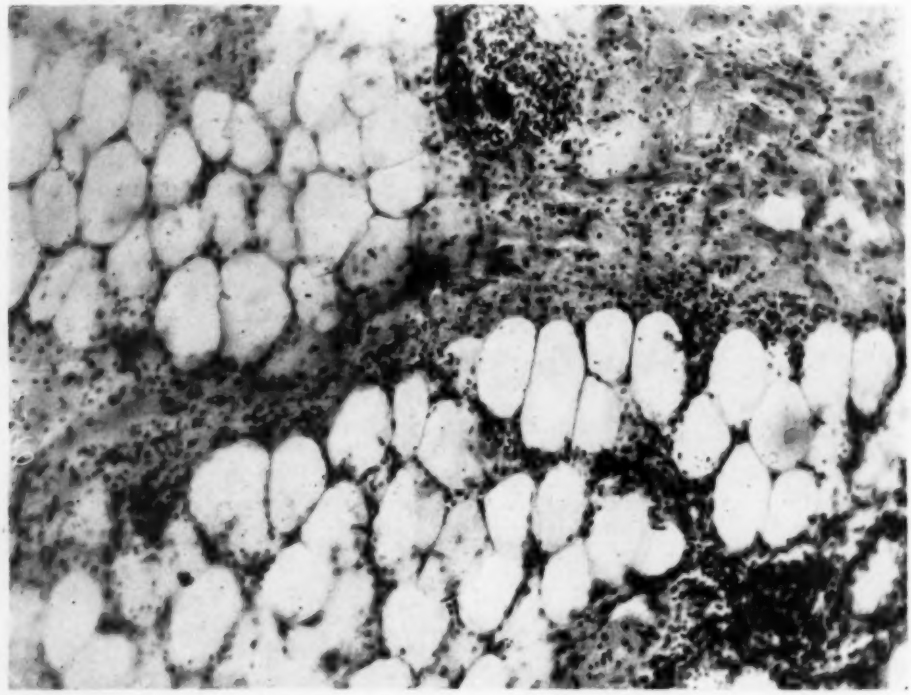

FIG. 9.—Case II. Marked cellulitis of fat and subcutaneous tissue and infection about sweat glands.

risk—a patient with hypertension and damaged kidneys—she was unable to survive the large tissue damage.

The disadvantages of débridement are obvious.

1. It is a radical procedure with considerable operative risk to a devitalized patient. Islands of epithelium in the hair follicles, sweat and sebacious glands may be sacrificed that might be saved.

2. The after-treatment is extremely painful and infection is very apt to follow.

3. Skin grafting must usually be performed to cover the defect. If the condition of the patient is poor and infection present, skin grafting may be so long delayed that a scar tissue base may form beneath the granulation tissue and a second extensive débridement must be performed to make a satisfactory field for the grafts.

Pathology.—Sections are presented of two cases where débridement was

performed. Case I.—Two days after injury. Case II.—Six days after injury.

Case I shows almost complete destruction of the epithelium. In places there are islands which are masses of ill-staining nuclei with loss of cell differentiation and occasional epithelial masses resembling pearls. The connective-tissue stroma is œdematous and in places necrotic; the fat shows œdema and in places death of the nuclei. Some of the hair follicles appear relatively normal and others are necrosed. This early débridement undoubt-

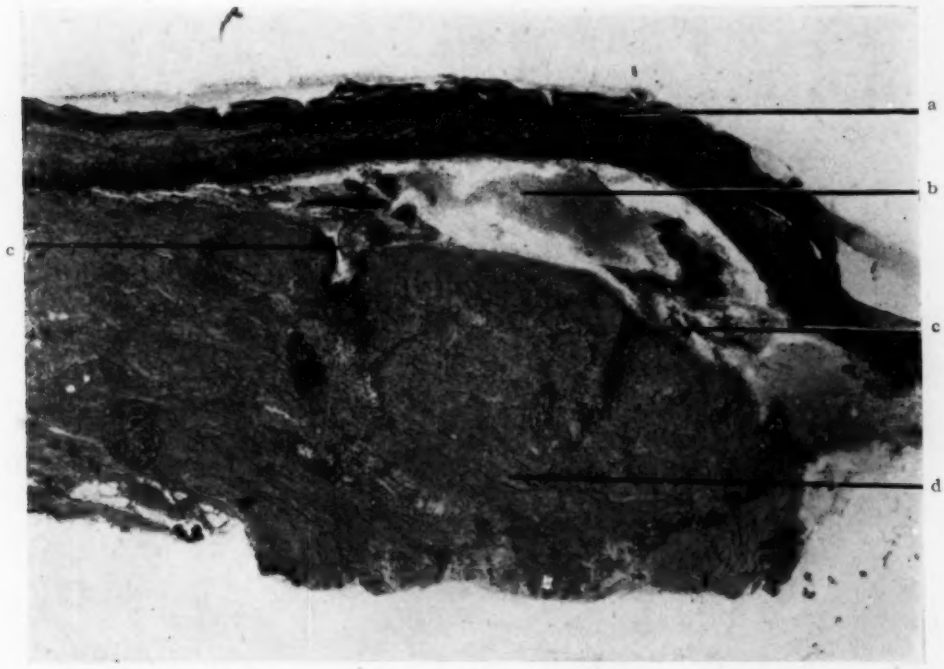

FIG. 10.—Case III. Low powered view, child eight years, treated by tannic acid. Section removed four days after burn. a. Tannic acid membrane. b. Separation zone. c. Hair follicle. d. Subcutaneous connective tissue. (See Figs. 11, 12 and 13.)

edly removed islands of epithelium in these hair follicles that might have been sources for later regeneration of the skin. Blood-vessels have their walls intensely damaged and there is apparently a coagulative necrosis of the blood. One can realize from this section the tremendous amount of absorption of toxic products.

Case II.—After eight days one sees a condition like a sequestrum in osteomyelitis; an area of necrosed tissue separated from the living tissue by a zone of leucocytes. In this specimen the subcutaneous tissues and fat are markedly infiltrated with leucocytes and infection appears to be present. This was taken from the patient who showed such marked improvement following débridement.

In sections made from one case, a child of ten years, four days after treatment with tannic acid, the tanned membrane with its beginning separation zone is shown. In the high power view a thin layer of flat epithelium

extending from the hair follicle is seen spread out over the connective tissue. We assume that this is new epithelium beginning repair, originating from the hair follicles while the membrane is still in places attached. This proliferated epithelium is a strong argument in favor of the tannic acid treatment as opposed to débridement. We believe also that this tissue injury is less than that shown in the cases treated by débridement. This, however, might be attributed to the intensity of the burn.

There is still some confusion in the minds of a great many, relative to the

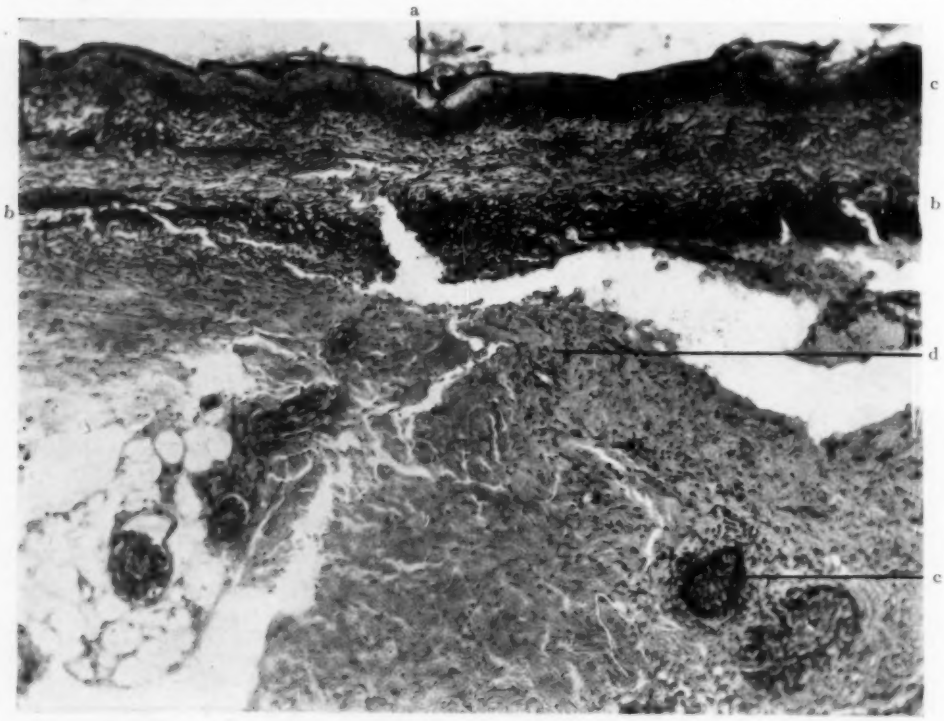

FIG. 11.—Case III. High powered view. a. Tanned membrane. b. Separation zone. c. Hair follicle. d. Connective tissue.

incidence of ulcers in the duodenum or in other parts of the intestinal tract, following cutaneous burns. From our review of the literature we are unable to find any reference to fresh duodenal ulcers found at autopsy.

Bardeen and Weiskoten have made particular studies in quite a number of burn cases, dying within a few hours from their injury and also in late cases, both in adults and children. The intestinal tract contained many punctate hemorrhages and occasional small ulcers in the jejunum and the ileum. Weiskoten emphasized the profound destruction and characteristic appearance of the adrenals. Three of our cases that died had marked distention, suggestive of intestinal lesion but unfortunately due to the fact they were coroner's cases, we were unable to perform autopsies.

Tannic Acid.—For about six months we have used tannic acid for the local treatment as described by Davidson. The skin is first carefully cleansed.

A 2½ to 5 per cent. aqueous solution of tannic acid is then applied as a wet dressing for twenty-four hours. When the burned area becomes a mahogany brown; the dressing is removed and the patient is treated with heated dry air. Usually a tent is erected over the bed and the electric lights inserted. The patient is kept as surgically clean as possible. Davidson has propounded the theory that tannic acid coagulates protein and precipitates the poisonous materials in burned tissue—thereby preventing their absorption.

In practice patients treated by tannic acid have a firm mahogany membrane

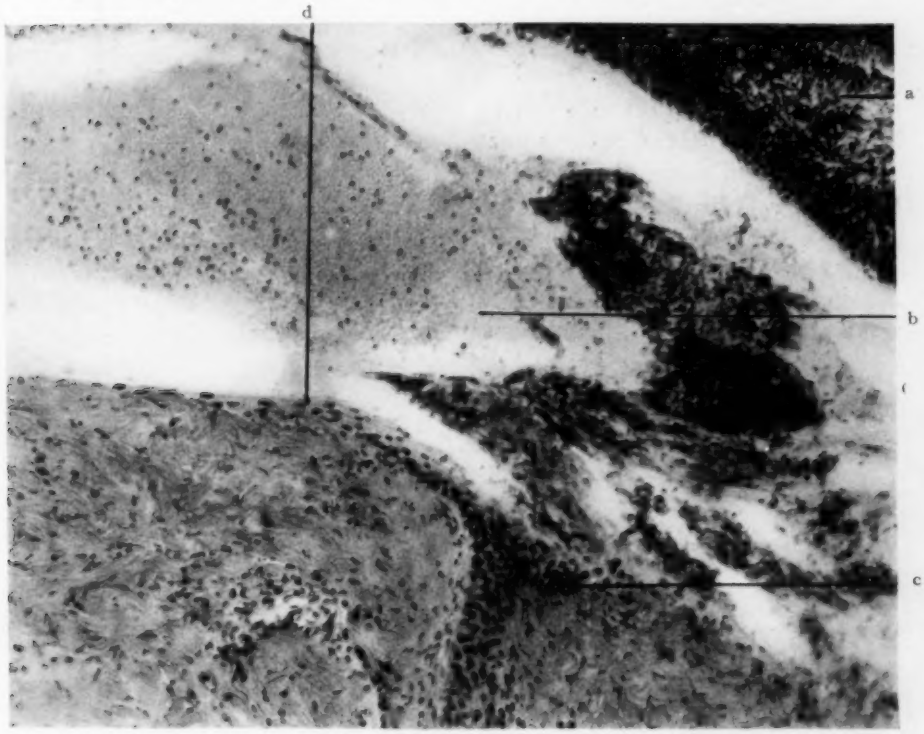

FIG. 12.—Case III. High powered view. a. Tanned membrane. b. Separation zone. c. Hair follicle. d. New epithelium arising from hair follicle spread out over connective tissue. It is assumed that this is beginning epithelization arising from the hair follicle, while the tannic acid membrane is still *in situ*.

in the burned area—healthy skin is apparently unaffected by the treatment. The tanned area has a leathery consistency. Unquestionably there is less pain associated by this method of treatment than by any other procedure we know. We are all used to seeing a patient suffer intensely the first few days after a burn. Blisters that fill and refill after puncture—dressings that have to be changed daily with agony to both patient and surgeon alike. This is completely changed with tannic acid. The patient is in relative comfort for the first seven to ten days and may continue until cured if the burn be merely a first or second degree. The membrane should be left to separate of itself—epithelization occurs beneath it in superficial burns; often attempts at early separation cause bleeding and with bleeding comes infection.

TABLE III.
Cases Treated with Tannic Acid

Total number of cases	9
Cases improved or cured	7
Cases that died	2
Average length hospital stay (all cases)	30 days
1 case still in hospital	120 days
Mortality	22%

Comment Table III.—It will be seen that the mortality is less and the hospital stay shortened in cases treated with tannic acid.

Tannic acid seems to us the best method at present for the treatment of burns—it relieves pain, apparently diminishes absorption of toxic products and makes the care of patients much easier from all points of view. In two cases of complete circular burns of the extremities in children, the rigid membrane caused by tannic acid produced œdema of the distal parts and longitudinal incisions to the fascia were necessary to release the tension.

TABLE IV.
Cases Treated by Electric Cradle

Total number of cases	38
Cases improved or cured	19
Cases that died	19
Average length hospital stay (all cases)	21 days
Mortality	50%

Deaths: Extent of body surface involved 30 per cent. to 70 per cent., one case 44 years old died four days after admission, 12 per cent. body surface involved. (Very poor physical condition.)

Comment Table IV.—Cases were treated by this method prior to January 1, 1925. The mortality has been diminished with the later methods.

With first and second degree burns epithelization has often occurred by the time the slough has separated. We have had some deaths at three to four weeks in third degree burns, where, as will be shown in our analysis of deaths, we believe infection occurred beneath this membrane.

Analysis of Cases.—It is impossible to compile statistics of any value in a small series of burns. Too many extraneous factors must be considered, as, for instance, the age of the patient, the patient's general condition before the trauma, the amount of nerve shock due to the injury itself and finally and most important, the amount of surface area burned.

In this study we have attempted to estimate the burned area according to the enclosed chart. In reviewing a series of cases that have come in as emer-

gencies there are undoubtedly many inaccuracies and probably we have overestimated the burned surfaces. We have, however, tried to check this up as carefully as possible.

Our results show that the mortality per cent. and the length of hospital stay has been improved since the introduction of tannic acid.

TABLE V.

Cases Treated by Other Means

Boric Acid—Picric Acid—$NaHCO_3$ Mag. SO_4 Alone or in Combination

Total number of cases	50
Cases improved or cured	45
Cases that died	5
Average length hospital stay (all cases)	13 days
Mortality	10%

Comment Table V.—As will be seen by Table VII, there were cases of small surface area and very little therapy was required to prevent mortality.

Two cases treated with tannic acid: A woman, thirty-two years old, with burns of approximately 50 per cent. body surface and a woman of forty-two years with burns of approximately 50 per cent. body surface involved, died twenty-four and seventeen days, respectively, after injury. In both cases the membrane over the first and second degree burns had separated, leaving healthy epithelizing surfaces. The temperatures rose four or five days preceding death and the patients appeared septic. We believe that their lives

TABLE VI.

Average Hospital Stay of Recovery Cases Treated by All Methods

Débridement	104
Tannic acid	50.2
Electric cradle	39.9
Miscellaneous	14.2

might have been prolonged had we removed the sloughs covering the third degree portions, and treated the granulating surfaces by Carrel-Dakin or wet antiseptic dressings.

Treatment of Contractures vs. Early Skin Grafting.—We have had two very depressingly bad results in circular burns of the thighs and legs in young children, where we attempted to apply extension by Bryant overhead traction to prevent contractures at the knee-joints. Before we realized what was happening pressure necrosis occurred at the anterior surface of the ankle-joint followed by deep sloughs. In one case marked lymphatic obstruc-

tion with œdema of the feet resulted. These children are markedly devitalized and do not stand any type of traction. We believe that contractures where there are circular burns should be prevented by nurse and doctor frequently during the day applying careful manual traction. Davidson in Detroit and Burdick and Beekman of the Children's Surgical Service, at Bellevue Hospital, have advocated early skin grafting as soon as sloughs separate and we are convinced that this procedure should be given precedent over the attempt to correct deformities. If skin grafting is delayed, there is a formation of

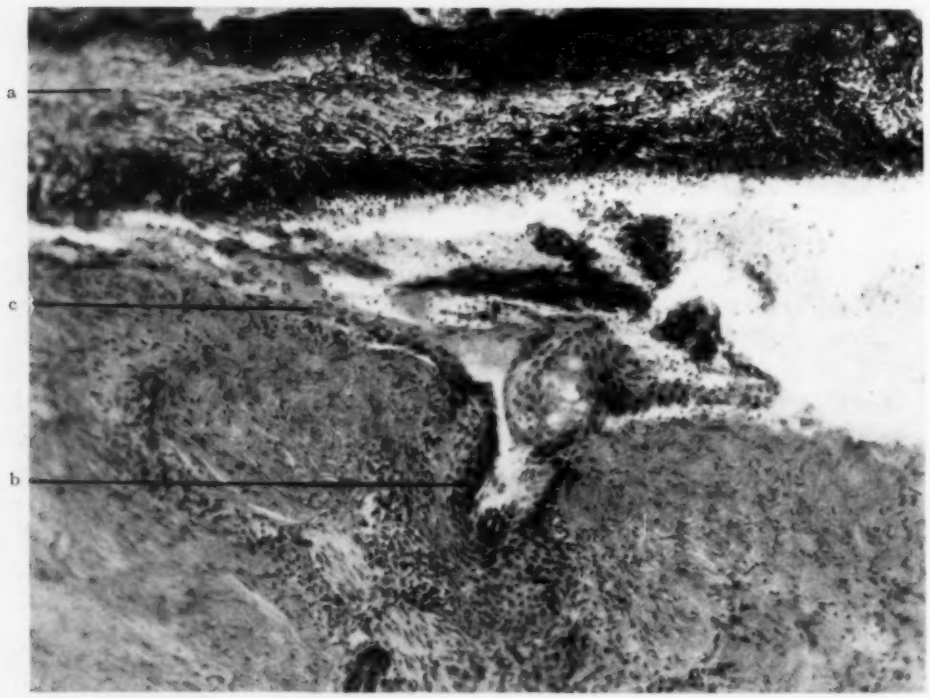

FIG. 13.—Case III. High powered view. a. Tannic acid membrane. b. Hair follicle. c. New epithelium spread out on connective tissue beneath tanned membrane.

unhealthy anæmic granulation tissue with a scar tissue base. In the two cases where we attempted traction in lieu of skin grafting, we have had to débride this scar tissue before we could have any success with skin grafts. Moreover, in one case where we grafted early and had contractures at the knee-joint, we obtained a perfect result by anæsthetizing the patient and extending the

TABLE VII.

Average Percentage Area Involved in Recovery Cases

Débridement	28.3%
Tannic acid	30%
Electric cradle	19.7%
Miscellaneous	11.2

FIG. 14.—Case IV. Section removed from child of nine years treated with tannic acid on admission. Section removed four days after burn, because child was running temperature and exhibited signs of infection. a. Tanned membrane. b. Hair follicle. c. New epithelium, spread out irregularly on connective tissue. d. Exudate of polymorphonuclear leucocytes. e. Sweat glands showing infiltration of polymorphonuclear leucocytes and evidence of infection. f. Small capillary containing numerous polymorphonuclear leucocytes.

knee. Epithelial and fascial tears in the popliteal space were created during this procedure and immediate skin grafts applied with a successful outcome. We now have an excellent anatomical and functional result.

Blood Chemistry.—The urea nitrogen content and blood sugars have been taken on a considerable number of these cases. We have found a slight preliminary rise of the blood sugar within normal limits. Urea nitrogen has in general been lower than normal, save where death was imminent. Never has it been higher, however, than 15 mg. per 100 c.c. of serum.

CONCLUSIONS

1. The use of tannic acid is a distinct advance in the treatment of cutaneous burns.

2. The systematic treatment of fluid depletion is of great value.

3. Patients with third degree burns often have late elevation of temperature and exhibit signs of infection. Life may be prolonged in these cases by removing the tanned membrane and treating infection.

4. Skin grafts should be applied soon after sloughs separate.

5. In children with circular burns of the extremities, caution should be exercised in attempting to correct deformities.

6. In deep burns of small surface area immediate débridement, associated with skin grafting, may be of value.

BURNS TREATED BY TANNIC ACID*

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The treatment of burns by the application of tannic acid, proposed by E. C. Davidson,[2] is a noteworthy contribution to medical therapy. The method consists in the application to the burned area of compresses saturated with two and one-half per cent., freshly prepared, aqueous solution of tannic acid. An innocuous coagulum of the burned protein is thereby produced which, when exposed to dry air, forms a parchment-like surface over the burn. This protective covering renders the area insensitive and prevents the loss of body fluid. The method was applied by Davidson in the treatment of twenty-five cases and his conclusions were as follows: 1. The preliminary treatment of burns with tannic acid compresses, followed by exposure to air, lessens toxæmia. 2. After coagulation of the devitalized tissue with tannic acid, the application of a wet boric-acid dressing apparently causes a return of toxic symptoms. 3. Tannic acid as an initial dressing on a burn is analgesic. 4. The subsequent use of the open-air method causes minimal trauma and promotes general comfort. 5. The local astringent effect prevents the loss of body fluid. 6. Secondary infection is markedly limited by the absence of a favorable nidus for bacterial growth. 7. Scar tissue formation has been less marked than that observed after treatment by other methods. 8. The protective layer of coagulated protein forms a scaffold for the growth of young epithelial cells over the denuded surface.

The purpose of this report is to record additional cases treated by tannic acid and to suggest a slight modification in the method of applying it.

The Method of Treatment.—The method as described by Davidson is as follows: "As soon as the patient is seen, he is given a relatively large dose of morphine sulphate hypodermically (for an average adult one-quarter grain) to alleviate the intense pain. The burned area is then covered with dry sterile gauze pads which are held in place by sterile gauze bandages. This dressing is then soaked with a 2.5 per cent. aqueous solution of tannic acid. This is thought to be the most desirable concentration, although solutions as dilute as 0.75 per cent. and as concentrated as 5.0 per cent. have been used in some cases described. It is essential that the tannic acid solution be made up fresh just before use, because it deteriorates upon standing with the formation of the far less astringent gallic acid. In order to prevent the deep caustic tissue injury found by Schuetz[4] to follow the application of concentrated tannic acid, small sections of the dressing have been opened for inspection at the end of twelve hours, eighteen hours, and again at the end of twenty-four hours. As soon as the part is found to have assumed a light brown color, all dressings are removed. In order to facilitate removal of the dressings without pain to the patient and without causing further trauma, it has been

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found desirable to wet the gauze with fresh tannic acid solution shortly before this is done. The wound is thereafter left exposed to the air, but is carefully protected from mechanical injury, chilling, and bacterial invasion by a suitable cradle draped with sterile linen. In the more serious cases artificial heat has been supplied by placing within the cradle so prepared one or more ordinary electric light bulbs. In a few cases 5 per cent. tannic acid ointment (made with equal parts of vaseline and lanolin as a base) was substituted for the aqueous solution. Although it appeared to have a definitely beneficial effect, it is far less efficacious than the former. The chief value of the ointment is in its use about the eyes, where the astringent solution cannot be used with entire safety. One of the most essential features of the management of all burn cases is that of keeping up the fluid balance in the body. This is accomplished by forcing fluids by mouth, where possible, or by hypodermoclysis, protoclysis or intravenous infusions according to the special indications in each case. Blood transfusion has been employed in some of these cases, apparently with favorable effects."

FIG. 1.—Burn involving the epidermis and dermis, coagulated by tannic acid and subsequently exposed to dry heat. The crust is intimately adherent to the underlying fat. In deep-seated burns serum or pus may collect beneath the crust necessitating its removal. This can be done by softening with vaseline. (Specimen taken from the midline of the epigastrium, Case IV.)

Coagulation of the burned tissue should be produced as rapidly as possible. A more intimate contact between the burn and tannic acid can be produced by spraying the burn frequently by an atomizer containing the solution. The burn is covered with a fine spray every half hour until the surface becomes brown or black. Blebs are opened as soon as they form and the epidermis is removed wherever it separates. The burn is exposed continuously to dry heat. Exposure to air seems to facilitate the process of tanning and exposure to heat hastens drying of the coagulum. An extensive burn can be coagulated completely in sixteen hours. A smooth indurated surface is produced which is entirely insensitive. If tannic acid be applied by compresses, the coagulum sometimes adheres to the compress which, when removed, leaves a raw surface. The spray is an improvement in the method of applying the solution. Ointments containing tannic acid were of relatively little value. If the burn involve the eyes, lips, nose and ears, these parts can be treated readily by a fine spray of the solution. The coagulum should be dried as early as possible. If the burn involve the subcutaneous tissues, several days may elapse before the surface becomes dry. We have found that the ordinary electric heater facilitates drying.

Toxæmia usually disappears three to five days after the burn is sustained depending upon the extent of the burn, the rapidity and degree of coagulation, blood concentration, excretion, etc. After this period has passed, the question arises as to the proper time to remove the coagulum. If the epidermis alone be involved, the crust separates at its margin as the new epidermis grows

beneath it. The crust, in the absence of infection, affords an excellent protective covering under which epithelium rapidly grows. It acts as a splint to the wound much as ambrine and other paraffin dressings do. The crust should not be disturbed until it separates. In extensive burns which involve only the epidermis, the crust will separate after two weeks, disclosing a nicely epithelialized surface. Where both layers of the skin are destroyed the crust remains firmly adherent to the underlying tissue, Fig. 1. In such cases regeneration of epithelium takes place only from the periphery and this is a relatively slow process. It may be advisable, in such burns, to remove the crust after two weeks and place grafts upon the base. If it is not feasible to graft the entire area because of its extent, that portion of the crust upon which the patient rests may be left in place while the accessible areas are grafted. After these grafts have taken, the remaining crust may be removed and grafting completed. Pus may collect beneath the crust and this will necessitate its early removal. The crust can be removed by softening it with vaseline and cutting it free where it is attached to the subcutaneous tissue.

Report of Cases.—Case I.—A well-developed man, aged fifty-five, was burned in an explosion of illuminating gas. In his escape from the flame he fell one flight of stairs and became unconscious. When seen in the hospital one and one-half hours later, he was suffering intense pain; 0.015 gm. morphia was given. The burn was extensive. It included the entire body surface above the waist line except the area protected by the suspenders. The fingers, hands, forearms and areas on the face were burned to the underlying muscle; elsewhere, including the upper arms, chest, back, neck, face and ears, the burn involved the epidermis and to a large extent also the dermis. The lips and mouth were burned deeply. The patient was in a mild degree of shock. The body surface was cold and clammy; the pulse rate was 52; the blood-pressure was, systolic 110, diastolic 64. The mental condition was clear. The presence of deep-seated abdominal tenderness indicated the possibility of intra-abdominal injury; pain was present over several ribs, but there was no definite evidence of fractures. The red cell count was 4,520,000, white cell count 14,400, hæmoglobin 70 per cent. The blood urea was 80.2 mg., uric acid 5.3 mg., and blood sugar 170 mg. per 100 c.c. The urine showed a heavy trace of albumen, no sugar, many casts, a few white cells and no red cells.

Compresses saturated with 2.5 per cent. aqueous solution of tannic acid were applied to the burned areas about four hours after the burns were received. The patient was in great agony; 0.01 gm. morphia was given. During the first twenty-four hours an attempt was made to keep the patient warm; 0.025 gm. morphia was required, and 9400 c.c. of fluid were taken. The patient vomited a small quantity of blood during this period. The compresses were saturated several times with the solution of tannic acid. The patient gradually became more comfortable. The compresses were removed after twenty hours. The burned area was indurated and light brown. Numerous large blebs under the epidermis were removed and these areas presented no discoloration. The patient at this time had little pain and during the second day received only 0.01 gm. morphia. Five per cent. tannic acid ointment was applied to the mouth, face and ears, and compresses were reapplied to those areas where blebs were present. Elsewhere the burn was exposed to dry heat. The patient received 6600 c.c. of fluid during the second day. The temperature was 37.8° C. and the pulse was 80. The red cell count was 6,952,000, white cell count 22,000, hæmoglobin 120 per cent. The urine contained no albumen, no sugar, a few casts, a few white blood cells and no red blood cells. Regardless of the high fluid intake, the blood was becoming concentrated.

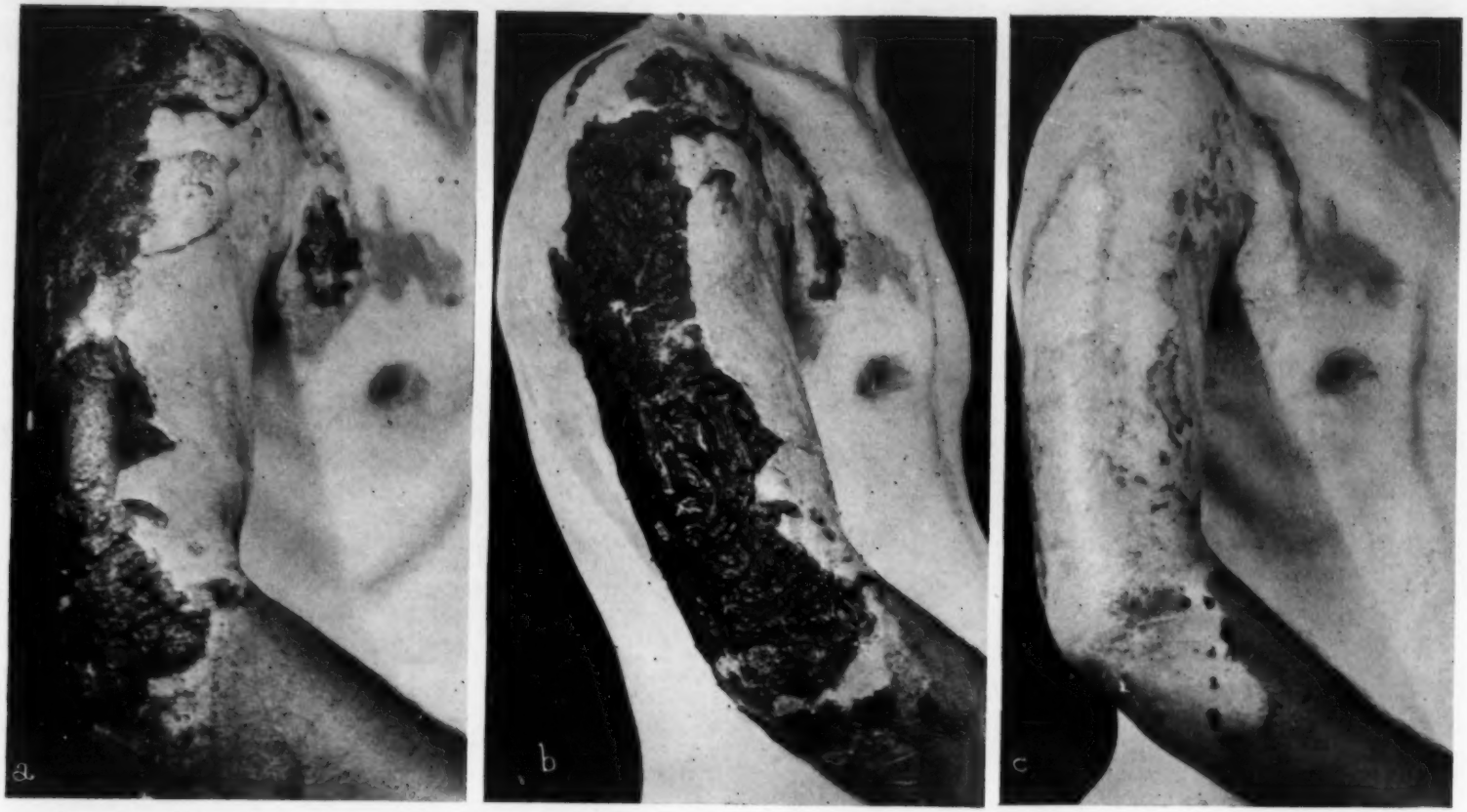

FIG. 2.—Case II. a. The burned area coagulated by tannic acid. The crust is intimately adherent and furnishes an excellent protective covering. b. The crust after exposure to dry heat. It is beginning to separate at the edges where new epithelium has grown beneath it. c. The appearance after thirteen days. The crust has been removed and the surface is covered with epithelium.

FIG. 3.—Case III, one-seventh of the body surface was involved. a. The coagulum after eighteen hours. The burned area has been sprayed with tannic acid every hour. b. The appearance after four days. A well defined crust has formed. Œdema of the scalp persists.

During the third and fourth days the burned area was exposed to dry heat. The surface now became a well-defined dark crust resembling parchment. It, however, did not become completely dry. The patient did not complain of local pain, but abdominal distress, anxiety, and restlessness developed and these required increasing quantities of morphia. On the afternoon of the fourth day he vomited large quantities of fluid containing blood. Toxicity increased. The red cell count was 6,400,000; hæmoglobin 105 per cent.; the blood urea was 200 mg., uric acid 8.1 mg. and sugar 100 mg. per 100 c.c. The urine showed no change. Death occurred on the fifth day. The terminal blood urea was 280 mg., uric acid 6 mg. per 100 c.c. Necropsy was not obtained.

Comment.—Toxæmia developed regardless of the application of tannic acid. The burn, however, was extensive and deep, and, furthermore, it was not known what internal burns were sustained. The coagulum did not become completely dry. Difficulty in drying the crust was experienced also in later cases of deep burns.

Case II.—A well-developed man, aged thirty-eight, received a superficial burn with boiling water over the arm, shoulder and neck. The burn was treated with vaseline gauze for three days before admission to the hospital. During this period the patient suffered intense pain. After admission the blebs were opened, the loose epidermis was removed, and compresses of tannic acid were applied. When the burned area was completely tanned, it was exposed to air and the surface became dry. Pain completely disappeared. The temperature dropped from 39° C. to 37° C. and subsequently remained at the normal level. The blood urea and uric acid were slightly elevated for three days and then became normal. The urine was normal.

The tanned crust was intimately adherent and furnished an excellent protective covering to the burn, Fig. 2a. As new epithelium formed beneath the crust, the edges gradually separated and were excised, Fig. 2b. The remaining crust was softened with vaseline on the thirteenth day and removed without difficulty, Fig. 2c. The surface was everywhere covered with new epithelium except over one small area at the elbow, where the burn involved both layers of the skin. Exposure to the air was painful and saline compresses were used to protect the new epithelium. They were removed after twelve hours and the patient was discharged.

Comment.—This case illustrates the striking decrease of pain following the application of tannic acid. This is an important feature of this method of treatment. It also demonstrates the rapid growth of epithelium beneath the crust when only the epidermis is destroyed.

Case III.—A well-developed boy, aged thirteen, was burned by flaming gasoline over the abdomen, chest, shoulders, neck and face, Fig. 3a. The area as calculated was one-seventh of the body surface.† The burn extended into the subcutaneous tissue over the chest, neck and areas on the face; elsewhere the skin alone was involved. The patient was brought to the hospital one-half hour after the accident occurred and compresses of tannic acid were applied immediately. At that time he was in severe pain and 0.03 gm. codein was given; the skin was cold; he did not respond to questions. The face was greatly swollen and blebs were appearing under the epidermis. The temperature was 37.2° C. and the pulse rate was 70. One hour after admission the red cell count was 5,520,000, white cell count 34,000, and hæmoglobin 95 per cent. The blood urea was 33 mg. and blood sugar 160 mg. per 100 c.c. The urine showed traces of albumen and sugar, a few white blood cells, no red cells and no casts.

During the first twenty-four hours the face and scalp became markedly swollen. An effort was made to keep the patient warm. About 5000 c.c. of fluid were taken.

† This was calculated by accurately tracing the burned surface and measuring the area by a planimeter. The total body surface was computed by DuBois' formula [3].

FIG. 3.—c. The crust has been removed. The superficial burn is covered with new epithelium. The dark area represents a granulating surface which formed where both layers of skin were destroyed. This subsequently was grafted. d. The appearance two months after the burn was received.

Early in this period it was noticed that the compresses did not come into intimate contact with the burned area. They were, therefore, removed and tanning henceforth was carried out by spraying the parts with tannic acid solution from an atomizer. The surface was exposed to dry heat. Delirium developed and towards the end of the first

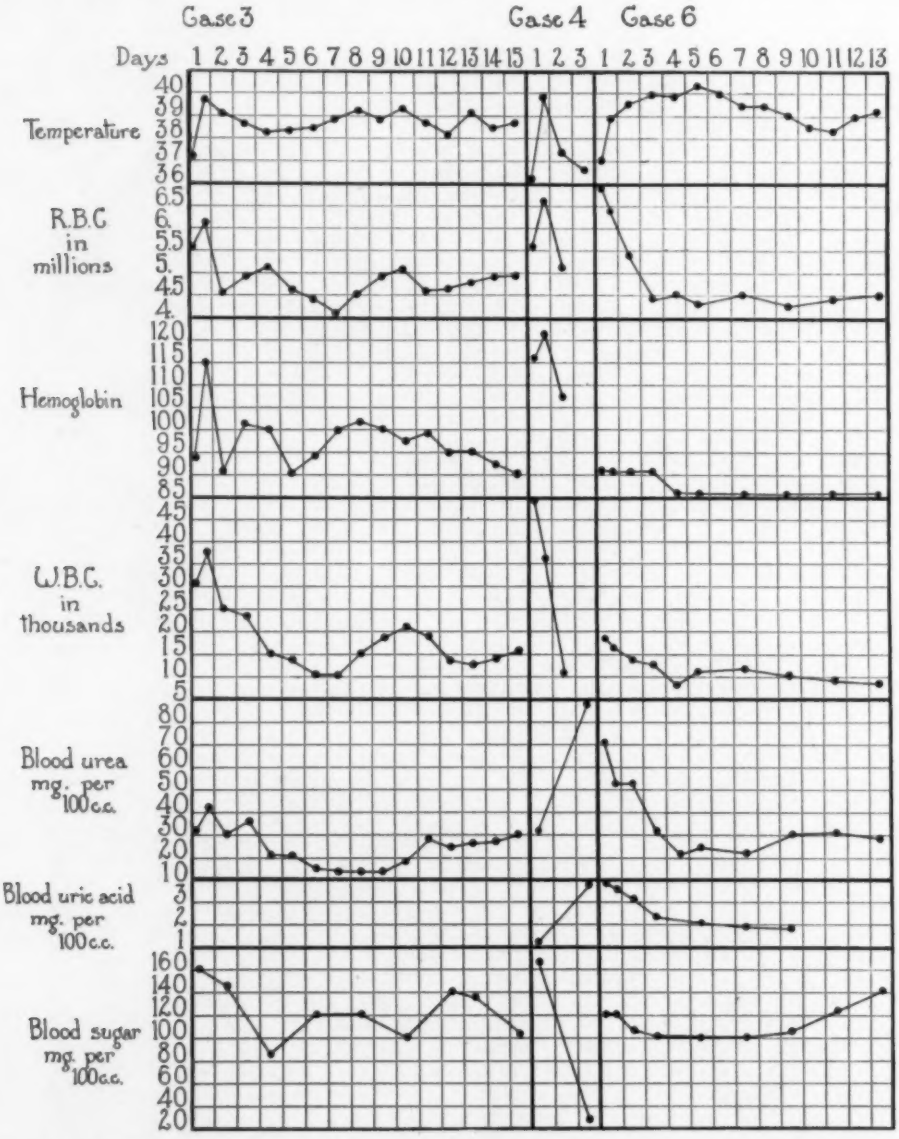

FIG. 4.—Graphic record of temperature and blood studies in Cases III, IV and VI. A striking decrease in toxæmia is indicated during the first four days in Cases III and VI. In Case IV the blood concentration, as indicated by determination of the red cell count and hæmoglobin, was reduced but toxæmia increased and death occurred.

day the temperature was 39.7° C., pulse rate 153, red cell count 6,300,000, white cell count 38,000, hæmoglobin 115 and blood urea 42 mg. These determinations were higher on the first day than they were during the subsequent clinical course, Fig. 4. The burned area after the first twenty-four hours was covered with a dark brown crust

which was intimately adherent and, in spite of exposure to dry heat, remained cool and moist, Fig. 3a. It was painless to touch and the patient suffered no discomfort.

The condition improved towards the end of the second day. Delirium disappeared. He vomited once but the vomitus did not contain blood. The temperature was 39° C., pulse 124, red cell count 4,500,000, white cell count 26,000, hæmoglobin 94 per cent.; the blood urea was 32 mg. and blood sugar 150 mg. per 100 c.c. The crust was black and continued to be cool and moist. Dry heat was continued. There was no pain. Five litres of fluid were taken and about the same amount was administered daily during the succeeding period.

During the next two days the condition was one of constant improvement. At the end of the fourth day the temperature was 38.2° C., pulse 90, red cell count, 5,200,000, white cell count 13,000, hæmoglobin 100 per cent.; the blood urea was 20 mg. and blood sugar was 90 mg. per 100 c.c. The urine contained a few white blood cells, no sugar and no albumen. The crust was almost completely dry. It was insensitive and afforded an excellent protective covering, Fig. 3b.

The tanned crust over the area of superficial burn gradually separated at its margins showing newly formed epithelium beneath it. This was removed as it separated. Serum and pus collected under the area that was burned more deeply, and on the tenth day there was a rise in temperature, pulse rate, white cell count and blood urea, Fig. 4. This change was due to the presence of infection and it was decided to remove the crust. This was the area which subsequently had to be grafted, Fig. 3c. Vaseline was spread over the crust. Twenty-four hours later it was soft and could be removed with little difficulty except in the areas where the burn was deepest. Here the crust had to be cut away. This newly exposed surface was sensitive to the air and the patient complained of being cold. It was cleansed with compresses of saline and Dakin's solution applied alternately. The temperature, pulse rate, white cell count and blood urea began to fall after removal of the crust and evacuation of the pus. On the twenty-fifth day full thickness pinch grafts were placed on the granulating base. To prevent contracture of the neck the patient was placed on a Bradford frame with the head hyperextended.

Slight contraction of the neck occurred. The patient was discharged from the hospital about two months after admission, Fig. 3d.

Comment.—This patient recovered from a burn which seemed sufficiently extensive to be fatal. The toxæmia and blood concentration, however, strikingly decreased during the first four days. This was indicated by determinations of the blood urea, red cell count, hæmoglobin and white cell count. This early improvement in the condition, undoubtedly, can be attributed to the action of tannic acid in converting the burned tissue into an innocuous coagulum which prevented the loss of body fluid. It was for the same reason also that the injury suffered by the kidneys was slight. The urine did not contain red blood cells or casts, and the presence of albumen, sugar and white blood cells was transient.

The value of the spray in applying tannic acid to the face around the eyes, nose, mouth and ears was demonstrated by early tanning of these parts. This method is more efficacious than the use of compresses or ointments.

The rapidity with which the coagulum dries varies with the depth of the burn. If the burn involves only the epidermis, the coagulum can be dried in a day, but if it involves the subcutaneous tissue the crust remains boggy for several days. There probably is some absorption from the crust as long

as it contains moisture. Certainly, if the crust be moistened with compresses of boric acid after it is dried, absorption will occur as indicated by the development of toxæmia in Davidson's cases. For this reason the crust should be dry. If serum or pus collect beneath the crust, absorption will take place. This occurred in the above case on the tenth day and disappeared after the crust over these infected areas was removed.

Case IV.—A girl, aged four and one-half, received an extensive burn over the body, legs, arms, and face from her clothes which caught afire, Fig. 5. The burned area as accurately calculated was 28 per cent. of the body surface. The burn seemed to involve both epidermis and dermis. She was admitted to the hospital about one hour after the accident occurred. At this time the temperature was 36.6° C., pulse rate 100, respirations 20; white cell count 48,900, red cell count 5,610,000, hæmoglobin 116 per cent.; the blood urea was 30 mg., uric acid 1.2 mg., and blood sugar 170 mg. per 100 c.c. She was in severe pain; the skin was pallid, cold and clammy.

The blebs that appeared under the epidermis were opened and strands of epidermis that had separated were removed. The burned areas were sprayed with 2.5 per cent. aqueous solution of tannic acid every hour during the first day and exposed to dry heat. The urine obtained about eight hours after the burn was received contained sugar but was otherwise normal. Fluids were retained by mouth and rectum; 3100 c.c. were given during the first fifteen hours.

Towards the end of the first day the temperature rose to 39.8° C., pulse 120, respirations 30, white cell count 36,600, red cell count 6,600,000 and hæmoglobin 121 per cent. The burned area was covered with a dark brown crust, and the patient seemed to be in no discomfort. The fluid intake was 2500 c.c.

On the third day the temperature was 37.5° C., pulse rate 114, respirations 24, white cell count 13,000, red cell count 5,050,000, hæmoglobin 108 per cent. The urine contained albumen, sugar, white blood cells, red blood cells, no casts. The fluid intake was 2100 c.c. The child was somewhat listless and suffered no pain. Towards the end of the third day the patient refused water by mouth; she vomited fluid containing blood; drowsiness increased and death occurred.

Necropsy findings were charring of the tongue, acute inflammation of the trachea, œsophagus, stomach and duodenum, with multiple ulcers of the stomach and duodenum, œdema and congestion of the brain, congestion of the lungs, fatty infiltration of the liver and congestion of the kidneys. A post-mortem specimen of blood contained 85 mg. of urea and 3.8 mg. of uric acid per 100 c.c., Fig. 4.

Comment.—This patient sustained a fatal burn involving 28 per cent. of the body surface. In children a burn involving one-seventh of the body surface is considered fatal, whereas in adults a burn involving one-third of the body surface is considered fatal. In children a burn of apparently slight severity sometimes may be fatal.

At the beginning of the third day the patient seemed to be recovering from the initial shock. The blood concentration, as indicated by the hæmoglobin content and the red cell count, was approaching normal. The white cell count had fallen from 48,900 on admission to 13,000. The presence of drowsiness, however, indicated toxæmia and this, after it was first noticed, seemed to develop quickly. It is probable that bleeding followed by transfusion would have been beneficial in this case. The necropsy findings, as listed above, are characteristic lesions of extensive burns, Bardeen.[1]

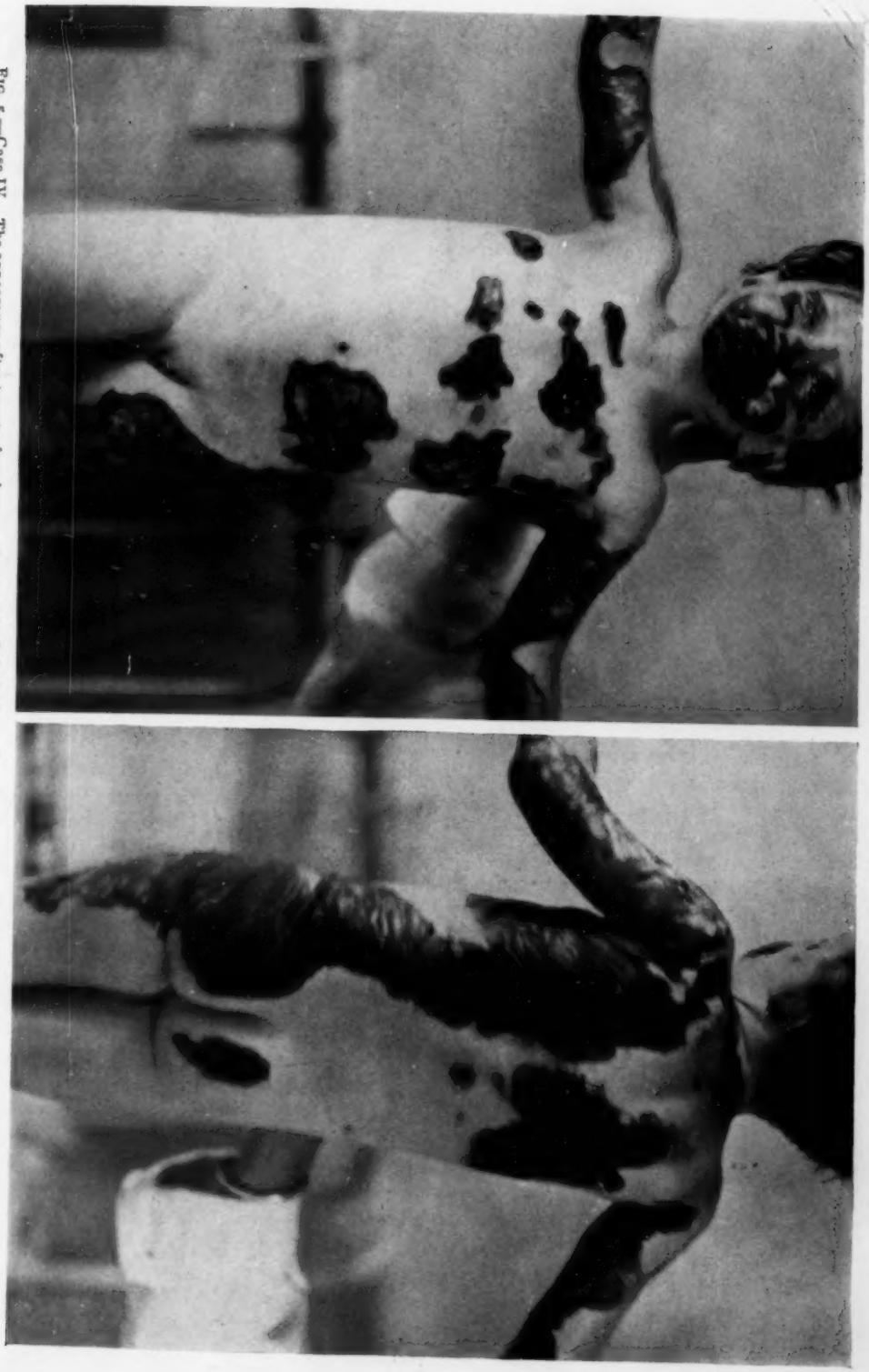

FIG. 5.—Case IV. The appearance after twenty-four hours; 28 per cent. of the body surface was burned. The child could lie on her back without discomfort.

CASE V.—A woman, aged twenty-nine, received burns of both hands while attempting to remove the clothes from her child (Case IV). The burn extended from the wrists over the entire surface of the fingers and the palm of each hand. It involved chiefly the epidermis but in a few places the dermis was also destroyed. Large blebs formed within the first few hours. These were opened. The epidermis of the palms and fingers separated and was removed; the nail of the right index finger was lost. Pain was intense and required morphia. Upon admission to the hospital, the red cell count was 5,290,000, white cell count 17,200, hæmoglobin 109 per cent. The blood urea was 21.0 mg., uric acid 1.4 mg., and blood sugar 180 mg. per 100 c.c. The urine contained albumen and sugar, no blood cells and no casts.

The hands were soaked intermittently in tannic acid solution, and at the end of twenty-four hours the burned areas were well encrusted, Fig. 6. Pain almost entirely disappeared. At this time the red cell count was 4,960,000, white cell count 19,400 and hæmoglobin 97 per cent. The blood sugar became normal and sugar disappeared from the urine. During the next five days the urine contained albumen, a few red cells, a few white cells, no casts. The urea and uric acid content of the blood remained normal.

The hands were kept dry and the crust began to separate at its edges almost immediately after it became dry. Epidermis regenerated rapidly beneath the crust and the burn was healed almost completely after two weeks. Skin grafting was not necessary. There was no contracture of the fingers.

Comment.—The absence of pain was striking in this case. There was not the slightest discomfort after the coagulum had formed. The growth of epithelium beneath the crust was rapid. The absence of contracture is noteworthy.

CASE VI.—A well-developed man, aged forty-one, was burned over the back, left chest, and left arm, Fig. 7. Both layers of the skin were destroyed and the head of the radius was exposed. On arrival at the hospital one hour after the burn was received, the patient was suffering severe pain. Repeated doses of morphia were required. The temperature and pulse rate were normal; the patient showed no signs of shock. The red cell count was 6,848,000, white cell count 17,800, hæmoglobin 90 per cent. The blood urea was 70 mg., uric acid 3.8 mg., creatinine 2.2 mg., and sugar 120 mg. per 100 c.c. The urine contained albumen, but no sugar, blood cells, or casts. On the following day blood cells and casts were present.

Blebs were opened and loose epidermis was removed. The burned areas were sprayed with tannic acid and exposed to dry heat. At the end of twenty-four hours a moist brown crust had formed. The temperature on the first day was 39° C. and the pulse rate 130. Frequent doses of morphia were necessary. Eight litres of fluid were taken. At the end of four days the red cell count, white cell count, hæmoglobin, and blood chemistry dropped to normal, Fig. 4. Casts and blood cells disappeared from the urine. The temperature frequently reached 40° C. during the first week and gradually thereafter dropped to 38° C.

The treatment subsequently consisted in exposing the burned surface to dry heat and forcing fluids. After the first week pus began to collect in places under the margins of the crust on the hand and forearm. Here it was excised and the surface was covered with rubber tissue. After three weeks the remaining crust on the arm and the anterior portion of the chest and abdomen was removed. Because of the depth of the burn only a small proportion of the surface was epithelialized. The base was treated with compresses of saline and Dakin's solution, and at the end of one month full thickness pinch grafts were placed. While these grafts were taking it was necessary for the patient to lie on his back. The crust over the back, therefore, was not removed except where pus collected. When the patient could lie on the abdomen, the remainder of the crust on

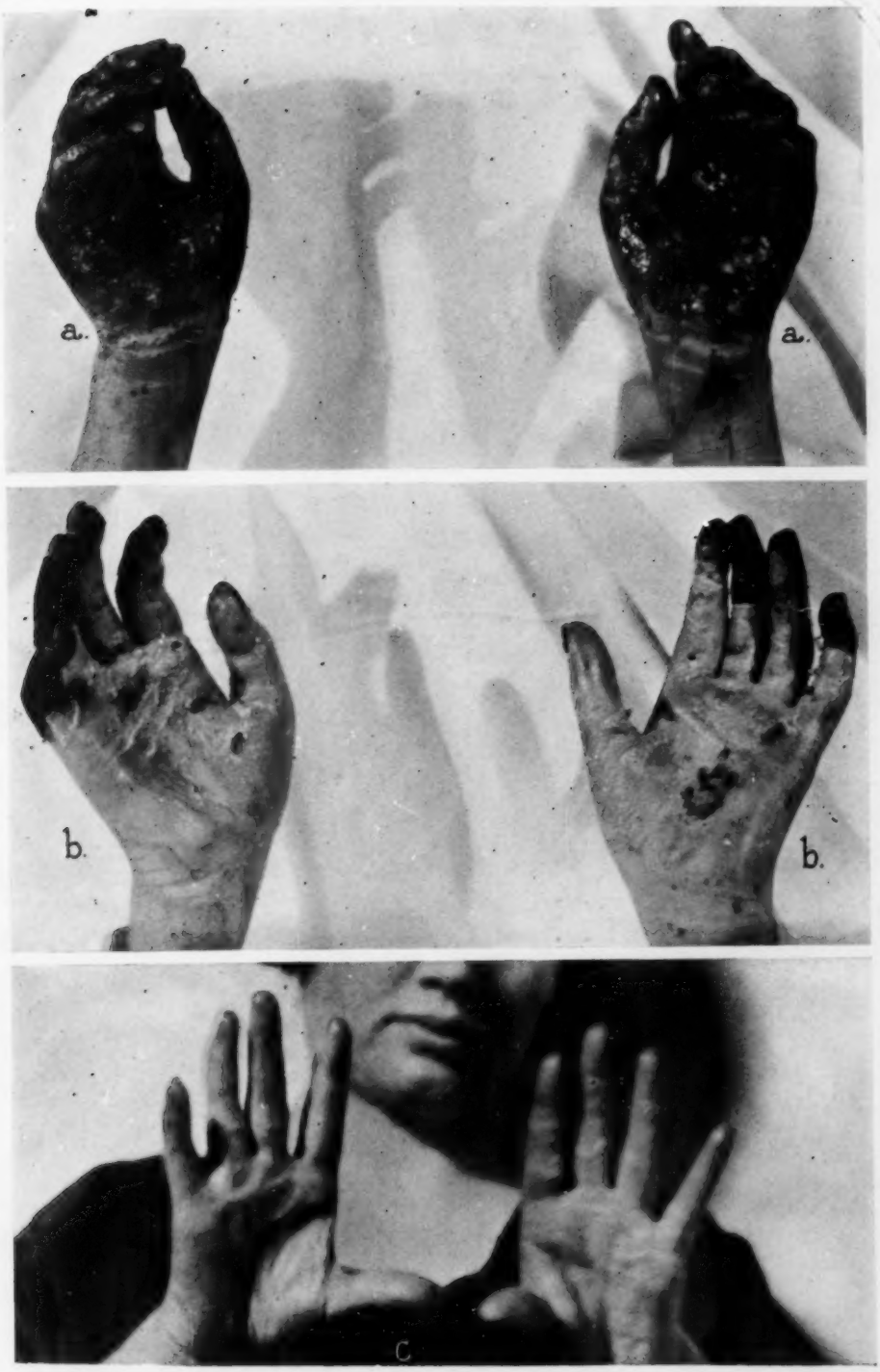

FIG. 6.—Case V. a. The hands at the end of twenty-four hours. b. The hands fourteen days later. New epidermis has grown beneath the crust. c. The hands two months later. There is no contracture of the fingers.

FIG. 7.—Case VI. The appearance on the third day. The crust is dry.

the back was removed and the surface prepared for grafting. The wound everywhere became epithelialized.

Comment.—This patient recovered from a deep and extensive burn. Toxæmia disappeared in four days. The clinical course was not without pain. Both layers of the skin were destroyed over an extensive area and regeneration of epidermis beneath the crust was slow. Almost the entire area was grafted. The crust over the back was useful to support the patient while the grafts on the chest and abdomen were taking.

CASE VII.—A well-developed boy, aged three and one-half, was burned by boiling water over the left forearm, hand, left flank, thigh, buttock, back, abdomen and perineum,

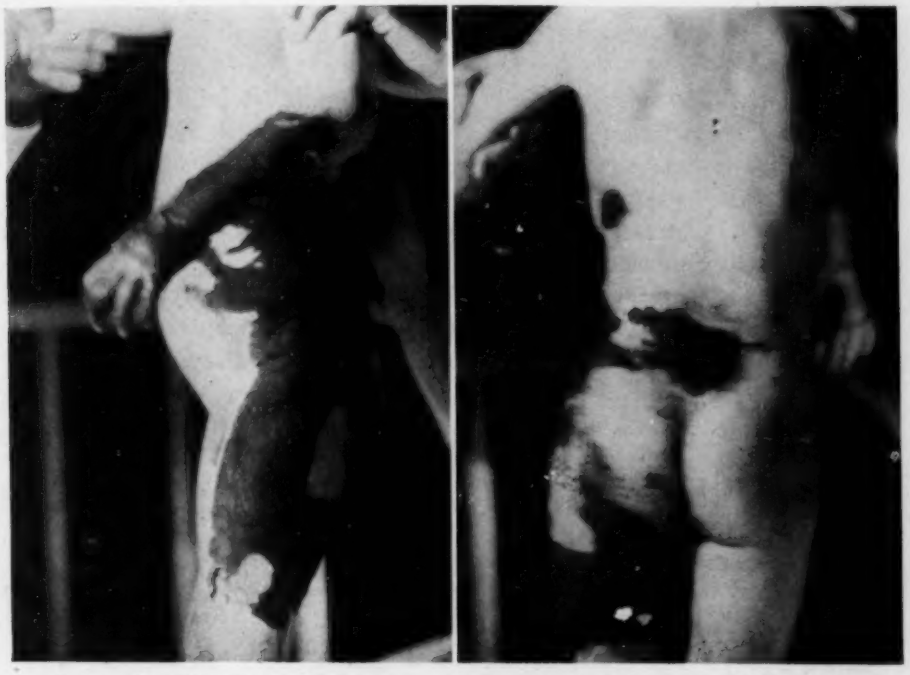

FIG. 8.—Case VII. The extent of the burn and the appearance of the crust on the second day.

Fig. 8. On admission to the hospital one hour later, he was in acute pain. One-half grain codein was given. The burn involved both layers of the skin but nowhere extended into the subcutaneous tissue. The child was placed between sterile sheets; blebs were opened and loose skin was cut away. An electric heater and a cradle with lights were arranged to keep him warm. The burned area was sprayed with a fresh solution of 2.5 per cent. tannic acid every half hour. During the first twenty-four hours the temperature rose to 39° C. and the pulse to 100. The red cell count was 7,190,000, white cell count 28,600. The blood urea was 24.8 mg. and the uric acid 1.9 mg. per 100 c.c. The urine showed no albumen, no sugar and no cells. Pain entirely disappeared and the child dozed a large part of the time. About four litres of fluid were taken.

On the second day the burn was covered with a brown crust. A few blebs had formed. These were opened and the loose epidermis excised. The temperature was 39.5° C., pulse 110, red cell count 6,220,000, white cell count 18,200. The blood urea was 30.3 mg., creatinine 1.4 mg. and blood sugar 66 mg. per 100 c.c. The urine showed a trace of albumen, no sugar, no cells and no casts. Two litres of fluid were taken.

On the third day the burned area was well incrusted, dry and entirely insensitive. The temperature continued to rise and reached 40.5° C., pulse 146. The red cell count dropped to 5,340,000, white cell count 7,350. The blood urea was 31.9 mg., creatinine 1.5 mg. and sugar 79 mg. per 100 c.c. The urine showed a heavy trace of albumen, no sugar, no cells and no casts. Two litres of fluid were taken. The patient was in no pain but was somewhat drowsy.

During the subsequent nine days the temperature varied from 38.5° C. to 40.5° C., and the pulse from 120 to 150. The red cell count remained normal. The blood chemistry remained normal. The white cell count was elevated because of absorption of serum and pus which collected beneath the margin of the crust.

On the twelfth day the crust was removed and the surface dressed with compresses of Dakin's solution. The temperature and pulse thereafter began to fall and six days later were normal.

The dermis was not so extensively destroyed as to require grafting. Such areas were epithelialized from the margin and the wound was healed completely within five weeks.

Comment.—The burn was followed by an immediate rise in the concentration of the blood as indicated by an increase in the red cell count. After the burn had become incrusted, the red cell count strikingly fell to normal. The patient was somewhat drowsy, but the urea content of the blood indicated little toxæmia. Toxæmia, undoubtedly, would have become pronounced had not the burned tissue been rendered innocuous by tanning. The increased temperature that persisted during the first two weeks probably was produced by serum and pus that collected beneath the crust. After the crust was removed and compresses of Dakin's solution applied, the fever subsided.

Case VIII.—A well-developed man, aged forty-one, was burned in an explosion of illuminating gas over portions of the face, neck, arms, forearms, hands, chest, abdomen and back. The burn was extensive but superficial and involved only the epidermis. When seen at the hospital one-half hour later he was suffering severe pain and 0.015 gm. morphia was given. The temperature and pulse were normal. Blebs were opened and loose epidermis was removed. The burned area was sprayed frequently with tannic acid and exposed to air. The relief from pain was striking. Two hours after the accident occurred the red cell count was 5,418,000, white cell count 13,800 and hæmoglobin 123 per cent. The blood urea was 31.2 mg., uric acid 2.2 mg., creatinine 1.0 mg. and sugar 110 mg. per 100 c.c.

Six hours later a light brown coagulum was formed. Spraying was discontinued after twenty-four hours. The coagulum became a crust that was black, dry and firmly adherent. The fluid intake was seven litres. The temperature was 39° C. and the pulse rate was 96. The urine contained white blood cells, no albumen, no sugar. The patient was entirely free from pain.

On the second day the red cell count was 4,448,000, white cell count 15,000 and hæmoglobin 95 per cent. The blood urea was 26.1 mg., uric acid 2.0 mg., creatinine 1.0 mg. and sugar 140 mg. per 100 c.c. The temperature was 38.0° C. and the pulse rate was 90.

During the next ten days the temperature was about 38.0° C. and the pulse rate about 90. The crust was dry. There was no absorption. Blood studies were normal. There was no discomfort. The crust was removed as new epithelium grew beneath it. Healing was complete in three weeks.

Comment.—This burn, although superficial, was extensive. The relief from pain was striking after tannic acid was applied. Toxæmia did not develop. The red cell count and the hæmoglobin content became normal as soon as the burn was tanned.

Discussion.—The striking and most important features of the tannic acid treatment are: 1, the control of toxicity; 2, the simplicity of method; and 3, the comfort of the patient.

The degree of toxæmia seems to be less marked in cases treated by tannic acid than in cases of similar severity treated by other methods. Cases for accurate comparison, however, are not available. In severe burns treated by tannic acid the urea, uric acid and sugar content of the blood attain a high level during the first twenty-four hours. After this period they begin to fall and they usually are at the normal level on the fifth day. Exceptions to this were present in the fatal Cases I and IV. The red cell count and the hæmoglobin content of the blood begin to fall after the first day when they are at their highest levels, and within a few days they are normal.

Superficial burns treated by tannic acid show little or no toxæmia. If the crust remains dry, the temperature, pulse and white cell count early become normal. If serum and pus collect beneath the crust, the temperature, pulse and white cell count become elevated, and when this occurs the crust should be removed. In deep burns some toxæmia may develop. The coágulum of deep burns dries slowly and it seems that some absorption takes place as long as the crust is moist.

The partial prevention of toxæmia seems to depend upon two factors. Precipitation of the protein and drying of the coagulum render the burned tissue innocuous, so that it is not absorbed. The almost waterproof covering afforded by the crust prevents loss of fluid and if large quantities of fluid are taken, the blood does not become concentrated.

The care of the patient becomes a relatively simple matter. There are no traumatizing dressings and no weeping wounds. Coagulation of the burned area by spraying tannic acid on it is easily accomplished and subsequent exposure to air and warmth without dressings is tolerated well by the patient. In first degree burns the crust is displaced by the new epithelium as it grows beneath it. In deeper burns the crust can be removed by softening it with vaseline and cutting it away. After its removal the base can be prepared for skin grafting by compresses of saline or Dakin's solution.

Without exception the discomfort from the burn was decreased after the application of tannic acid. The decrease in the degree of pain was affirmed by every patient and was experienced within a few hours after the application of tannic acid was begun. The tanned area becomes entirely insensitive due to the local analgesic action of tannic acid. It is possible for the patient to lie on the incrusted area without pain. In view of the discomfort that usually accompanies burns treated by other methods, the absence of pain alone in burns treated by tannic acid gives the method a conspicuous place in therapy.

The treatment of burns by tannic acid should be popularized. The solution can be made by the laity by mixing four teaspoonfuls of the dry powder in a glass of water. This will make approximately a two and one-half per cent.

solution. Tannic acid is easily procured and can be kept indefinitely as a powder. It should form an important adjunct to the equipment of first-aid stations of steel mills, mines, factories, etc., so that immediate application, either by means of compresses or the spray, could be carried out.

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STUDIES OF CALCIUM AND PHOSPHORUS METABOLISM IN THE FRACTURE OF BONES*

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Within recent years the study of calcium and phosphorus metabolism has attracted considerable attention. Very little of this work, however, has been directed to the rôle played by these salts in the process of ossification after fractures. Considerable research has been done on the growth and development of bone along purely histological lines, but investigations into the nature of the bio-chemical processes which govern normal and abnormal ossification have been few. A study of these processes must involve a consideration of the metabolism of calcium and phosphorus since these substances constitute the major portion of the bone salts.

In 1924, Peterson reported the results of "A Clinical Study," and "An Experimental Study of Ununited Fractures with Special Reference to the Inorganic Bone-forming Elements in the Blood Serum." He placed considerable emphasis upon the part played by calcium and phosphorus in bony union after fractures. He found that in many cases of non-union, "there is an underlying basis—which is made manifest as a deficiency in the concentration of the inorganic bone-forming elements of the blood." This deficiency existed in either a subnormal calcium or phosphorus content of the blood serum. Peterson used an empirical equation which he called the calcium-phosphorus product in order to show this deficiency. The product is obtained by multiplying the calcium by the phosphorus, both in milligrams per 100 c.c. of serum. The optimum product for healing he thought to be between thirty-five and forty, while in those patients with non-union a product of less than thirty was the rule. Little healing took place with a product between thirty and thirty-five. He found that when this deficiency was corrected union took place. The cases could be divided into two groups: (1) those who clinically show no callus and who chemically show a low calcium; and (2) those who show callus and in whom a low phosphorus is found.

This series of studies has been undertaken to determine whether various pathological processes involving the bony skeleton affect this metabolism. We hope to study a series of fractures, of bone infections, and of bone dystrophies. In this paper we are reporting the calcium and phosphorus con-

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tent of the serum in a small series of fractures which occurred, so far as we were able to ascertain, in otherwise normal individuals.

We were interested in the question as to whether or not this estimation might prove of clinical value in determining which cases would have delayed or non-union and in studying the methods by which a faulty metabolism might be corrected.

Since the work of Petersen had raised in many surgeons' minds the question as to whether or not it would be possible to hasten bony union by the administration of calcium and phosphorus to patients with fractures, it might be well to discuss briefly the metabolism of these agents. Telfer has shown that the amount of calcium and phosphorus eliminated depends upon the amount ingested. With a diminution in the intake of the elements there is a corresponding fall in the amounts excreted. When an excess of calcium is present in the ordinary diet there results an increased excretion of calcium in the feces with only a very slight rise in the urinary calcium. This increase of urinary calcium indicates increased calcium absorption, but as deWesselow has shown, this must be quite transitory since it is extremely difficult to raise permanently the calcium content of the blood. The effect of intravenous injections of calcium is transitory and deWesselow and others have failed to find any rise in the blood calcium after the ingestion of calcium salts. The effect of an increase of calcium in the ordinary diet results in an increase of the phosphorus in the feces and a decrease of it in the urine. The simple addition therefore of an excess of calcium to the diet tends to restrict the phosphorus to the intestinal contents, where it is eliminated as tri-calcium phosphate. For example, the addition of ten grams of calcium carbonate to the diet, per day, results in a decrease by one-half of the urinary phosphorus with the resultant increase of fecal phosphorus.

Telfer and Paton, during some experiments on calcification in dogs, found that 88 per cent. of the phosphorus ingested was excreted in the urine. On the same diet with the addition of a large excess of calcium lactate only 15 per cent. of the ingested phosphorus appeared in the urine, but a greatly increased amount was found in the feces. They found that when a large excess of calcium was added to a diet deficient in fat, the urine can be rendered phosphorus free, thus preventing any phosphorus absorption. The degree of deviation of the phosphorus to the urine is roughly proportional to the amount of fatty acids in the feces and consequently to the extent to which fatty acids have displaced phosphoric acid from its normal combination with calcium in the intestine. The excess of phosphorus over the equivalent amount of available calcium is absorbed and a small proportion of this may be retained, the major portion, however, is excreted in the urine.

All evidence seems to point to the fact that, after the ordinary diet, only a very small portion of the calcium ingested is ever absorbed and that the total amount of calcium and phosphorus eliminated by the feces and the urine is nearly proportional to its intake. It will thus be seen that the addition of these elements to the diet indiscriminately may not only produce no beneficial

results, but it may even prove harmful in that a negative balance may actually occur.

The ordinary diet contains sufficient mineral matter for body metabolism. Whether or not this can be utilized, of course, is another matter. The problem as it relates to fractures is one of fixation of the absorbed calcium and phosphorus in the bony skeleton. Deficient fixation may be the result of defective absorption. Telfer and Paton have shown that the fixation of phosphorus in the bony skeleton was dependent upon a simultaneous fixation of calcium. The two elements are so closely interdependent in their excretion and utilization that the metabolism of one cannot be considered without that of the other.

Telfer, and later Orr, Holt, Wilkins, and Boone have shown that the factor above all which favors a solution of the calcium phosphate in the gastro-intestinal tract is acidity. The absorption of calcium is initially dependent upon the free acid of the gastric juice and foods that are acid-forming evidently increase calcium retention and fixation. Collip has recently demonstrated the value of a parathyroid extract given subcutaneously in increasing calcium concentration in the serum of the blood. It may be that this extract will prove of value in those cases where an increase of calcium is desirable. Alkalis or base-forming foods have a contrary effect. Absorption therefore is normally restricted by the alkaline reaction of the intestinal secretions. They found that the absorption of phosphorus occurs freely even under pathological conditions and is difficult to restrict except by the addition of a large excess of calcium to a diet relatively poor in phosphorus. If the calcium retention can be increased, increased phosphorus retention will follow since calcium fixation is necessary before phosphorus retention can occur.

Since the phosphorus of most diets is in excess of the calcium, the conversion of the calcium which escapes absorption into tri-calcium phosphate is almost inevitable. The addition of these elements to a diet already containing an adequate amount of them for normal nutrition, therefore, would appear to us to be useless and we do not believe that in individuals whose ossification has been normal and in whom there is no reason to suspect defective retention of calcium and phosphorus the administration of these elements will be of value.

Method.—Blood was withdrawn from the vein after a fast of from twelve to eighteen hours, and its serum was examined for calcium concentration by the Tisdall modification of the method of Kramer and Tisdall, and for the inorganic phosphorus concentration by the Briggs modification of the Bell-Doisy method. We have accepted as the normal range in adults of inorganic phosphorus the figures suggested by Tisdall, 3.2 to 4.3 mgms. per 100 c.c. of serum. In children it is higher. The calcium content of the serum in normal individuals varies from 9 to 11 mgms. per 100 c.c.

In ten of the cases studied in our series ossification has been normal following the injury. In several of the patients more than one bone was

fractured. The bones fractured were the tibia (3), fibula (3), radius (6), ulna (5), and femur (2).

The calcium and phosphorus content in mgms. per 100 c.c. of serum are given in Table I. The product is given although we do not believe this empirical equation is of use.

It will be seen from a study of this table that while the calcium-phosphorus product is in every case with the exception of the second, (S. K.), above 35,

TABLE I

Age	Calcium mgms. per 100 c.c. serum	Phosphorus mgms. per 100 c.c. serum	Product
N. L., 36	10.1	3.79	40.30
S. K., 26	10.4	3.09	32.13
C. C., 17	10.2	4.20	42.84
A. C., 40	10.9	3.85	41.06
L. F., 62	10.5	3.69	38.75
B. L., 50	10.6	4.37	46.32
M. G., 43	10.6	5.66	59.99
J. B., 30	10.6	3.89	41.03
L. F., 44	10.7	4.30	46.01
R. L., 15	10.4	4.55	47.32

normal union occurred in S. K. even though he sustained a fracture of the femur and also one of the radius.

We also studied five cases in which delayed or non-union had occurred. The results of our work are given in Table II. Delayed union was assumed

TABLE II

Age	Time since fracture	Calcium mgms. per 100 c.c. serum	Phosphorus mgms. per 100 c.c. serum	Product
H. M., 36	3 months	11.5	2.93	30.47
M. B., 39	4 months	10.4	3.95	40.68
C. D., 12	8 weeks	10.2	4.51	46.00
L. K., 38	9 weeks	10.9	3.85	41.97
T. B., 33	6 weeks	10.1	3.59	36.26

when over six weeks had transpired from the time of fracture with no evidence of calcification by Röntgen-ray examination.

The average product for these cases is not lower than that for Table I, when we consider that the product in children is higher than that in the adult since the serum phosphorus is higher in the younger individuals. Case I (H. M.) is low, but in Case II (M. B.) the patient had a fracture of the

tibia and fibula and also one of the femur. The femur united while the tibia remained ununited. Surely deficient calcium-phosphorus metabolism played no part in this patient.

Telfer, in a study of rachitic infants, found a normal calcium-phosphorus content of the serum, but a defective percentage retention resulting in a negative balance. It may be that in the cases of delayed or non-union a defective retention or negative balance may be present. In order to determine this it will be necessary to study the ratio of calcium-phosphorus intake to excretion. This entails considerably more work, but should be done to establish the part played by this metabolism in those cases whose calcium-phosphorus serum content is within normal limits.

There may be an adequate absorption of these elements from the intestine, but a failure to use them at the site of calcification. The reëxcretion of the greater part of the normally absorbed calcium and phosphorus which would follow failure of fixation at the site of ossification would result in diminished retention of both elements. If it can be shown that non-union may result from faulty retention with a diminished or negative balance, the production of a positive balance by the administration of the parathyroid serum may then be of definite value. Since this serum increases the calcium absorption and retention, it will indirectly increase the phosphorus retention and in those cases in which defective ossification occurs, a restoration of normal retention and fixation might induce repair.

We believe, however, that in the normal individual the metabolism of these elements plays only an indirect rôle in delayed or non-union, and that other factors well understood play the major rôle.

SUMMARY

1. We have attempted to evaluate the part played by calcium and phosphorus in normal and abnormal ossification.

2. We have attempted to show that the absorption, excretion and utilization of calcium and phosphorus are not simple problems, but are highly technical.

3. The mere addition of these substances to the normal diet is probably useless.

4. In certain cases of delayed or non-union deficient retention and fixation of calcium and phosphorus may result in non-union, but this cannot be recognized from blood serum estimations.

SPINAL ANÆSTHESIA*

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Spinal, or more properly intradural or subarachnoid anæsthesia, is that form of regional analgesia produced by the injection of a local anæsthetic drug into the subarachnoid space. It is essentially a dorsal or sensory nerve root block. During the past six years in the course of the performance of three thousand six hundred and sixty-eight (3,668) operations on the Urological Service of Bellevue Hospital, we have come to use this form of anæsthesia more and more. It has so gained in favor as we learned more of its possibilities that it has now become a routine procedure in our operating room. We wish to present herewith a summary of its use in four hundred and ten (410) cases. While we realize that this is a comparatively small series, its use in these cases has been carefully studied from two angles, particularly; the development of a simple and safe technic and a comparison with the other forms of anæsthesia we have employed. The majority of these patients were nephropathic. In many the renal impairment was extreme. Especially in this type of operative risk does spinal anæsthesia recommend itself to the surgeon as the ideal. This applies to operations below the diaphragm.

In 1888, Corning, in an attempt to relieve the pain of spinal disease, injected a cocain solution between the spinous processes, producing in reality a paravertebral anæsthesia. This was, however, the inception of intradural anæsthesia. Bier in 1899 injected cocain into the subarachnoid space and the same year Tait performed the first operation under spinal analgesia. The method was at once adopted but because of a number of untoward results and cocain deaths following its use, was temporarily abandoned to be resumed soon after the discovery of stovain by Fournier in 1903, and more particularly after the isolation of novocain by Einhorn in 1904.

In spite of numerous obstacles hindering its more general adoption, a careful study of the subject thoroughly convinces one that spinal anæsthesia is rapidly gaining ground from year to year, especially among the younger generation of surgeons. Chief among these obstacles is a prejudice wrought of ignorance of the method and its proper usage. Also, occasional unpleasant results because of improper selection of patients, at times unsatisfactory anæsthesia, and now and then a death, occur in the hands of the untrained.

Although there are certain contraindications to and at times disadvantages in the use of spinal anæsthesia, its simplicity and ease of administration, the complete muscular relaxation, excellent anæsthesia, minimal risk, and absence

*From the Urological Service of Bellevue Hospital.

of disquieting sequellæ, make it an ideal anæsthetic from the standpoint of the surgeon. All surgeons can perform a satisfactory spinal puncture and there is no reason why the method herein described cannot be followed and satisfactory anæsthesia obtained. Each year in the operating room, we teach and permit a number of Fourth Year Medical Students to give these anæsthetics. They obtain uniformly good results, as do the House Staff who give most of our " spinals." With surgical asepsis, the danger of meningeal infection with lumbar puncture is nil. The drug is sterile in sterile ampoules and infection from this source is negligible. Sophoteroff has recently reported a series of two thousand five hundred (2500) cases in which he has injected tablets of the drug dissolved in spinal fluid, the tablets being merely passed through a flame twice to kill the external saprophytic organisms. He has had no untoward results and reports better anæsthesia as there is no decomposition of the drug by the brief heating.

Technic.—One hour before operation, morphine sulphate gr. ¼, and atrophine sulphate gr. 1/150 are given. If the patient is extremely nervous, hyoscin gr. 1/200 serves admirably as a sedative and permits one to proceed peacefully with the lumbar puncture. The patient is placed in the upright position sitting cross-wise of table, feet hanging down, body inclined forward, elbows resting on the knees. It is well to have an attendant assist the patient in the maintenance of this position. The skin of the lumbar region is painted widely—we use picric acid solution (5 per cent. picric acid and 50 per cent. alcohol)—and the location of the various lumbar spinous processes determined. If the field of operation lies below the umbilicus but does not require the opening of the peritoneum, as for procedures such as perineal section, perineal prostatectomy, hemorrhoidectomy, penile amputation, leg amputation, or fracture of the lower extremity, the site of injection is between the third and fourth lumbar vertebræ, a " low spinal." For operations like suprapubic prostatectomy, bladder operations, the space between second and third lumbar is selected. For intra-abdominal operations, all viscera below the diaphragm may be anæsthetized by injection between the twelfth dorsal and first lumbar vertebræ. We have had no experience with the extremely high spinals used by Jonnesco.

Having selected the point for puncture, the skin is first anæsthetized with novocain, the whole tract down to the dura is infiltrated. Often enough, the dura will be anæsthetized. It is surprising how painless the entire procedure can be rendered if this preliminary local anæsthetization is applied. Not infrequently it determines the success of the later anæsthesia, that is from the psychic standpoint.

A fine lumbar puncture needle with sharp point and blunt bevel is then introduced and a small amount (2–3 c.c.) of spinal fluid very slowly withdrawn into the sterile ampoule of novocain crystals. The ampoules which we use are prepared for us by Metz & Co. They are provided in various dosages. When dissolved the novocain-spinal fluid mixture is slowly injected

into the spinal canal without barbetage (successive withdrawing and reinjecting) and the needle quickly withdrawn. A collodion dressing is applied to the wound. Slow injection without barbetage keeps the solution localized, producing a maximum in regional block. The slow withdrawal of such a small quantity, not over 5 c.c. at the most, produces a minimal disturbance of cerebrospinal hydraulics. This is in marked contrast to the withdrawal of 10–20 c.c. as in the technic of some. The reinjection of such a comparatively large amount causes undue diffusion of the solution and there is the danger of the anæsthetic getting beyond control. When injected there is always a certain amount of diffusion of the drug but slow injection of the hypertonic solution will reduce this to a minimum. The diffusion is directly proportional to the speed of injection, the amount injected, and the relative specific gravity of the solution. Spinal fluid alone has a specific gravity of 1.004–1.008, that of spinal fluid with novocain dissolved is slightly greater. Gilbert and Porter in experiments on cats, showed the bulk of fluid injected to be more important in diffusion than the concentration.

The drug is at once absorbed and fixed by the tissues, particularly by the dorsal nerve roots. As soon as the patient is arranged on the table, operative preparations may begin. The head and shoulders should be elevated for the first five to eight minutes, having him breathe consciously to offset any temporary respiratory disturbance. The patient may then be put in Trendelenburg position if so desired. He must be watched for the first ten minutes during which time a fall in the blood-pressure occurs (average 10–30 mm. mercury). The blood-pressure then slowly mounts toward normal again. After the first fifteen minutes, the only danger comes when the patient is raised from the Trendelenburg position to horizontal. Temporary bulbar anæmia sometimes occurs with shock symptoms of a greater or less degree. Care must be exercised that the change of position to the upright is made slowly! After operation, patient is returned to the ward, given fluids freely (they may be given during operation if desired), and allowed to eat when meal time comes and with nearly all of our patients, undesirable post-operative sequellæ have been nil.

Dosage.—The anticipated duration of the operation determines to a large extent the dosage of the drug. We have found that 50 mgm. novocain crystals will give an excellent anæsthesia for about one hour. We have used as high as 120 mgm. anæsthesia lasting about three hours but it has been only when these large amounts have been given that unfavorable reactions have occurred. One grain or 65 mgm. is a good average dose and is safe. Use of the drug in crystal form obtains the maximum anæsthetic action with a given amount of drug, there being no diminution of anæsthetizing properties by boiling. The crystals are sterile in sterile ampoules.

Within two or three minutes following injection, scrotal and perineal tingling, numbness or parathesia appear. This condition is followed by analgesia. At once the same succession occurs in the heels (same sacral innerva-

tion). Later the analgesia appears on the legs and finally on the thighs and lower abdomen. Preservation of motor power is not unusual. The explanation is that spinal anæsthesia is primarily a dorsal root block, the drug not spreading in all cases to the anterior roots. Occasionally the tactile sense remains although pain sense has disappeared. Little indeed is absorbed by the cord itself.

It is only when the drug diffuses upward to reach the rami communicans of the lower dorsal sympathetics that vasomotor disturbances become apparent. These disturbances range from pallor, sweating and giddiness to coma, imperceptible pulse, slow breathing, and at times inaudible heart sounds. The rami communicans are paralyzed, thereby functionally paralyzing the lower sympathetics, thus involving the cœliac axis. This results in a generalized

TABLE I.

	1920	1921	1922	1923	1924	1925	Total
Operations performed	624	623	632	655	574	550	3668*
Local	290	331	298	267	254	258	1698
General	329	255	301	297	206	172	1560
Spinal	5	37	33	91	114	120	410*
Operation deaths	40	45	61	42	57	49	294
Local	9	7	18	7	9	19	69
General	30	36	41	33	36	17	193
Spinal	1	2	2	2	12	13	32

*Including 10 spinals for cystoscopy.

splanchnic dilatation and the collection of a large volume of blood in the vessels of the abdominal viscera. Cerebral and bulbar anæmia ensues. The bulbar phenomena (nausea, vomiting, respiratory, and cardiac disturbances) are manifestly due to anæmia as they largely disappear when the patient is placed in the Trendelenburg position. Two of our patients went into shock from which they did not recover. Both were extremely toxic, essentially moribund, one with an extensive urinary extravasation, the other suffering from an enormous periurethral abscess. Each should have had a local anæsthesia for surgical procedure.

Large doses of caffein and adrenalin are indicated in this form of syncope and are the drugs of proven value. Adrenalin intravenously is the only drug of use in cardiac or vasomotor failure and usually serves to tide the patient over until vasomotor function and stability is reëstablished. Some have withdrawn the spinal fluid in hope of removing an excess of the drug but this is quite useless as absorption and fixation by the tissues take place within five minutes. Ten grains of caffein before operation is said to maintain a normal blood-pressure. We have not used caffein in this manner. We do urge the

taking of large quantities of fluid before and immediately following operation and believe that this in conjunction with a minimal disturbance of the intradural pressure explains the general absence of distressing sequellæ. It has been demonstrated that with an excess of body fluids, the secretion of cerebrospinal fluid is greatly increased.

Bellevue Cases.—During the past six years, three thousand six hundred

TABLE II.

Total operative mortality	8.0%
Local operative mortality	4.0%
General operative mortality	12.2%
Spinal operative mortality	7.8%

and sixty-eight (3,668) operations have been performed on the urological service of Bellevue Hospital. Of these four hundred and ten were performed under spinal anæsthesia. The number of cases with the various forms of anæsthesia used and the relative mortality of each are indicated in Tables I and II.

Comparing general and spinal anæsthesia, a difference of about 4 per cent.

TABLE III.

Gas Oxygen Ether, 1920 and 1921.

Diagnosis	Stricture	Periurethral abscess	Prostatic abscess	Extravasation	Misc.	Total
Cases	65	21	14	14	4	129
Death—Sepsis	3			2		5
Uremia	1			1		2
Pneumonia	2		1	4		7
Mortality						10.9%

Spinal, 1921 and 1925.

Cases	70	35	19	4	10	138
Death—Sepsis	2		3	2		7
Uremia	2					2
Pneumonia			1			1
Mortality						7.2%

mortality in favor of spinal anæsthesia is noteworthy. To ascertain whether this was generally true, in our series, we made an analysis of cases of a more or less general type—those requiring external urethrotomy for relief. Patients having general anæsthesia in 1920 and 1921 when we used spinal anæsthesia but little and those who had spinal in 1925, with those few having this form of anæsthesia in 1921 (when we first began using it) were chosen for

comparison. (See Table III). Here too is approximately the same difference of nearly 4 per cent. mortality in favor of spinal anæsthesia.

A rather striking difference in the ratio (7 to1) of immediate pulmonary complications should be noted.

Most of these patients were admitted in a semi-uremic state, often with extreme renal impairment. They were at best, poor surgical risks. The data obtained, however, from a study of this relatively small number of cases of a general type seems to indicate rather definitely that there is a slight (4 per cent.) mortality rate in favor of spinal anæsthesia. In a few of the extreme cases better judgment unquestionably would have employed local rather than either spinal or general anæsthesia.

Practically all deaths occurring after local anæsthesia were in those patients who had a suprapubic cystotomy performed preliminary to prostatectomy.

TABLE IV.

Age	10-19	20-29	30-39	40-49	50-59	60-69	70-79	80-90
Number cases.....	6	74	101	86	79	46	12	2

The greater portion of these were admitted in acute retention, uremic, some moribund. These patients really died of urinary sepsis. We have used sacral and parasacral in some twenty-six (26) cases, in four of which the anæsthesia was unsatisfactory and it was followed by spinal. At times when the spinal anæsthetic is given between the third and fourth lumbar vertebræ, the skin analgesia will not extend more than two inches above the symphysis. Here we use novocain locally in the unanæsthetized areas. In one case of urinary extravasation extending high onto the abdominal wall, anæsthesia to the nipples was obtained, and the whole flank was freely incised and laid open. In seven cases in which spinal was unsatisfactory, general anæsthesia was given. In a few cases in which the anæsthesia was not all to be desired, re-injection was performed with good results and no untoward effects.

Surgical shock is minimal because of the afferent nerve block, permitting no impulse to reach the brain.

Many have used spinal analgesia in children. We have not. Our youngest patient was fifteen years of age. Rocher reports its use without accident in a series of one hundred twenty-five (125) children whose ages ranged from four to fifteen years. Table IV indicates the ages of our patients in decades.

In performing suprapubic prostatectomy under spinal, there is no pain, but the patient will complain of a sense of pressure in the lower abdomen, the result of the energetic manipulations of the hand and enucleating fingers.

Post-operative sequellæ are reduced to a minimum. The patient is able to return to the ward, take fluids at once, usually eats soon after operation, and there is practically no distention. Nausea occurred in a fraction less than 2 per cent. of our patients and there were but three who vomited, one

only slightly. With novocain, nausea and vomiting are much less frequent than when stovain is employed. Too, the less the spinal fluid is disturbed (we draw off but 2–3 c.c.), the less will the vomiting reflex be stimulated. By the same token, the fewer the undesirable sequellæ.

Headache occurred in three per cent. (3 per cent.) of our patients. This is slightly less than that observed after diagnostic lumbar puncture (5 per cent). Unquestionably this is explained by the fact that the patients are kept in bed at least a week following lumbar tap and operation, whereas after diagnostic tap, they are up and about in a relatively short time.

As Sicard has demonstrated, a large needle may tear the dura, leaving a gaping wound through which spinal fluid may ooze rather rapidly. This may be the cause of an extreme headache. It is essential therefore to use a needle of small calibre with a rather blunt bevel, being sure that the obdurator fits snugly and smoothly at the point of penetration. This obviates tearing the dura.

Cervical rigidity (meningismus) was observed in one case and lasted but one day.

Indications.—The best risk for spinal anæsthesia is the patient in sound body. The mistake is too often made in the assumption that spinal is the anæsthetic of choice in the weakened, the toxic or the moribund. This is wrong. McNider has demonstrated the toxic effect of ether on the renal epithelium. A certain degree of acidosis accompanies all forms of general anæsthesia. This is absent with spinal anæsthesia and it is therefore the anæsthetic of choice in patients with advanced renal lesions and is especially useful in the hypertensives. We have occasionally used sacral and parasacral anæsthesia in thin individuals in whom the landmarks are readily made out but in the fat types, spinal may be given with far greater facility.

Contraindications.—Spinal analgesia should not be given to the hypotensive, toxic or excessively nervous patient. It should not be used if the patient is in shock, if an unusually long operation is to be performed, or if there are such marked embarrassments to the pulmonary or cardiac functions as large pleural or pericardial effusions, or large pulmonary tumors. It must be used with discretion. The technic itself is simple, and should not be a contraindication in the hands of the average surgeon. Diseases of the spine, brain tumors, particularly cerebellar growths, rule out this form of analgesia. The fact that spinal has once been used does not contraindicate its further usage. We have given it to one patient as many as six times, and Babcock has used it twelve times on one man.

Mortality.—The administration of over one hundred thousand (100,000) spinal anæsthetics is reported in the literature. The mortality varies from 1–200 to 1–5000 cases. Several surgeons have series of over 2500 without a death. Babcock has reported the largest number of personal cases (15,000). He believes that in selected cases the mortality should not be over 1–10,000. We had two deaths in moribund septic patients on whom this method should not have been used, and unquestionably we hastened their deaths. It must

be borne in mind, however, that general anæsthetics are not without definite risks, more especially in patients with grave cardio-nephropathies. In another hospital we have seen a patient die on the table with the administration of a sacral anæsthesia.

Complications.—If the drug reaches a high level there may be respiratory embarrassment. There is slowing of the respiratory rate. If the reaction is severe, cessation ensues. This usually yields to artificial respiration, caffein, or rebreathing, especially if stimulated with ether or nitrous oxid. The milder form which is more commonly observed is manifested by a slight slowing of respirations and a complaint of a compression about the chest. Exaggerated breathing on the part of the patient overcomes this. The milder form is secondary to bulbar anæmia and is not found without a certain degree of vasomotor disturbance.

We encountered a complication I have not found mentioned by others, the breaking off of the lumbar needle. In this case, the novocain was nearly injected when the patient became restless, straightened up on the table thereby breaking the needle off between the spinous processes. It was necessary to give gas-oxygen to cut down on and remove the needle. This was easily accomplished with no untoward results.

Trauma of the cord has been reported. If one is careful in making the puncture, and free flow of fluid is obtained, he may be certain that the cord is out of danger. There are no records of autopsy performed after a spinal death to reveal the condition of the spinal cord and meninges, hence we do not know exactly the pathological picture.

Convulsions are the result of injection of the novocain directly into the general circulation. Temporary urinary incontinence and retention have been observed. We have seen none of these. Nor have we seen ocular palsies.

Objections may be made to spinal anæsthesia on the ground that the anæsthesia is too brief for long operations, but rarely does one operate for more than an hour and a half. Failure to obtain anæsthesia may be due to either inert drug or the fact that the needle was not in the spinal canal. Occasionally the anæsthesia is delayed.

Against these objections may be weighed the excellent anæsthesia with the complete muscular relaxation obtained. There is a greater or less degree of local anæmia. Post-operative sequellæ are negligible. Especially are there no intestinal (distention), lung, or kidney complications due to the anæsthetic. The strain on sutures is absent. The patient is able to take fluids and food at once. Moreover, the fact that patients will submit to repeated spinal anæsthesia demonstrates that from the point of view of the patient, the method is meritorious.

CONCLUSION

The greater the experience with spinal anæsthesia, the more has it come to replace other forms of anæsthesia on the urological service of Bellevue Hospital.

It is not an anæsthetic for all patients, those to receive it must be selected particularly in respect to their blood-pressure. Hypotensives, especially if the systolic pressure is below 100 mm. mercury, are poor risks.

Occasionally untoward results do obtain with a spinal anæsthesia.

The dosage can be more or less regulated and by proper care at the time of administration the drug can be localized at a given level of the cord, affording a definite regional block.

From the standpoint of the surgeon, it is an ideal anæsthetic for operative procedures below the diaphragm.

The general post-operative mortality in this series of cases was about 4 per cent. less in those cases in which spinal anæsthesia was given; that of general anæsthesia being slightly over 12 per cent.

A SYSTEM OF CONTROL AND TREATMENT IN THE TOXIC GOITRE*

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It is an accepted fact that the patient with thyrotoxicosis deserves more particular consideration, more specialized study, more of mature and experienced judgment than is regarded as requisite for the successful treatment of the more common lesions for relief of which the surgeon may be called upon. Consider appendicitis and pelvic inflammation, gall-bladder disease, gastric or duodenal ulcer, malignant growths of the stomach, colon and uterus; to be sure nicety of judgment, technical dexterity and an understanding of the limitations of endurance in the individual case; these and other considerations must be grasped and appreciated to cope successfully with any or all of these more or less common ailments. Too much specialization of course is to be deprecated, but when human life is the criterion, there can be but one answer. Is it to be a mortality of one per cent. or better, or ten per cent. or worse? Accidental contact with the goitre problem, more or less as a collateral, but a very vital issue, has justified the conclusion that the goitre patient is better served by an organization that has been built up as the needs for special protection presented themselves, than when no organized effort has been made to safeguard the patient. Hence, as in other places, there has been evolved at the University Hospital a Thyroid Clinic, officered by representatives of the medical, surgical and X-ray services; in this Clinic all patients with diseases of the thyroid gland are registered, no matter on what service they may be entered originally, and on their discharge from the hospital the entire group is subjected to the same continuation of observations. Thus a board of control is established whereby each and every patient may have the advantages of a composite opinion as to what, in each instance, is the best method of treatment; while the uniform "follow-up" system at once constitutes the standard by which impartial judgment is entered up on the justice of the course pursued. Such an organization protects the patient from individual prejudices and is the means of accumulating impartial statistics that may be used to advantage in determining the relative merits of the different means of dealing with this complex problem.

None of us can have patience with or respect for the individual who is given to making such sweeping statements as these; one states that "every patient who is coöperative will recover under his system of treatment; another, "never saw a recovery following a thyroidectomy"; another finds that the

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majority of his cases respond to X-ray treatment. It is true that improvement may occur from many different forms of treatment; but it is equally true that improvement, often amounting to absolute cure, will occur in a certain per cent. of cases even though no treatment is instituted. Toxic goitre, especially the hyperplastic goitre, is a self-limited dysfunction. The perversion of function gradually subsides, or as expressed by the older writers, "the disease burns itself out" and the patient recovers. Unfortunately, however, most of the patients succumb before spontaneous recovery occurs. Then, too, natural remissions may occur at any time during the course of the disease, only to be followed by a period of more severe symptoms. We must be very careful, therefore, in compiling the end results of any special form of treatment, that our conclusions are not influenced by including these natural recoveries and remissions.

At the present time, surgical treatment offers to the patient suffering from hyperthyroidism, either from exophthalmic goitre or toxic adenoma, by far the best hope for recovery. A conservative estimate of operative results from various clinics shows that recovery is to be expected in about 60 per cent. of cases, improvement in 30 per cent., and no improvement in 10 per cent. The results of medical treatment could probably be indicated by reversing the order of these figures. X-ray treatment, while of some benefit to a large proportion of pure exophthalmic cases, is, according to those best informed on this subject, curative in a very small number.

Conflicting opinions as to the proper course of treatment to be pursued in the care of the toxic goitre patient, by men of high standing in their respective fields, led us to the conclusion that the individual patient could only receive proper attention by subjecting him to a careful study by representatives of the various specialities who are interested in the problem. Each case, after completion of a routine investigation in the Thyroid Clinic, is reviewed, classified, and disposed of according to the consensus of opinion of the composite group. This, however, is not the only useful feature of such a clinic. While under treatment by one department, the patient is frequently seen by consultants from the other interested departments, not only in order that his progress shall be impartially observed and evaluated, but also because of the frequent necessity of treating dependent complications which may require complete or partial revision of the originally planned method of treatment.

On the surgical side, we take advantage of this consultant service by having the internist from the Thyroid Clinic see every case at frequent intervals before and after operation. Cardiac complications are so frequent that they almost become a symptom of the disease; renal and gastro-intestinal complications are not infrequent. In the proper management of such cases, the aid of the internist is invaluable.

The surgical management of the toxic goitre patient is largely a matter of observing certain fundamental principles and applying them in a routine way to all cases, as it is impossible to prognosticate the post-operative reaction

by the degree of apparent toxicity. It is a common observation that many cases of moderately toxic goitre develop marked thyrotoxicosis following operation. We are convinced, therefore, that only by encompassing every patient, regardless of the degree of toxicity, with every safeguard at our disposal, can we uniformly prevent more or less serious post-operative reactions. Every toxic patient is placed on the anoci-association technic, put at absolute physiological rest, given mild sedatives as indicated, and iodine as a specific in certain cases.

The anoci-association technic, whereby the patient is kept in ignorance of the fact that he is to be operated, or of the time of operation if he has been previously told that an operation is necessary, is a valuable adjunct. Mental and psychic disturbances are avoided; the patient goes through the operation with a pulse rate of from 10 to 20 beats per minute slower than is seen in those patients who enter the operating room with the knowledge that they are to be operated; the immediate post-operative reaction is less severe, and occasionally patients leave the hospital without realizing that they have undergone an operation. Admittedly, such a procedure is only necessary in about 5 per cent. of cases; the remainder would withstand their operative procedure without any mental shock. It is impossible, however, to determine which patients belong to this group, so that for their protection all toxic patients are subjected to the same procedure.

Physiological rest is one of our most beneficial pre-operative measures. It is well known that the toxic patient shows marked improvement from this procedure alone. The pulse rate gradually subsides until a constant level is reached, the basal metabolism declines proportionately, and the patient gains weight.

Mental and psychic disturbances, as well as objective manifestations of nervous instability, are best treated by the regular administration of a mild sedative, which can be increased as indicated. Sodium bromide, reinforced by luminal each evening, is usually sufficient. These measures, together with the pardonable deception of the anoci technic, usually exert a marvellous change in the patient's mental condition, with a resultant improvement in the physical condition.

Administration of iodine as a pre-operative procedure in exophthalmic cases has become here, as in practically every other clinic, a routine. Its effect is so remarkable as to consider it as a specific. There are, however, many points to bear in mind in administering the drug. In the first place, its effect is transient. Maximum improvement occurs when just a sufficient amount has been given. Unfortunately, at the present time, there is no way, except clinical observation, by which the correct amount can be determined; in a general way we have found that the maximum effect is reached after giving Lugol's solution in doses of five minims, twice daily, for from seven to ten days. After this period, iodine not only does little if any good, but may be distinctly harmful. The second point to be remembered is that the beneficial results obtained by using iodine can seldom be duplicated if operation is

delayed, and later a second course of iodine therapy attempted. We have seen several cases benefited on their original admission, who have refused operation and left the ward only to return later with more severe symptoms. On their second admission, these patients have failed to show the expected improvement from iodine. There is still one more point to be remembered. Iodine is not to be considered as a curative agent. We have failed to see one case of exophthalmic goitre that has been permanently benefited by the use of iodine. The transient improvement should only be considered as an " induced remission " which serves its purpose by affording an opportune moment for surgical intervention.

In the treatment of toxic adenomas we are not entirely in accord with other clinics who are using iodine routinely. It undoubtedly benefits a large proportion of these cases, but we have seen some unfavorable reactions which make us very dubious of its routine indication. Under no circumstances should iodine be given to a patient with an adenoma, whether it be toxic or non-toxic, except when the patient is in a hospital where he is being prepared for operation. The incidence of induced hyperthyroidism from administering iodine to patients with non-toxic adenomas has reached appalling figures, not only from the indiscriminate use by the laity, but often by prescriptions from the practitioner. Iodine, while one of our most valuable adjuncts in the surgical management of hyperthyroidism, has probably done more harm to patients with goitre than any other drug.

Having utilized all these aids, the question then arises as to when the patient is to be operated and what operative procedure is to be instituted. Since the operative procedure is one of election, uninfluenced by immediate necessity, as often governs many general surgical problems, it naturally follows that operation should be performed when the point of maximum improvement is attained. This optimal point is determined by considering several factors. After several days of absolute physiological rest, it will be noticed that the pulse rate gradually declines, the basal metabolism falls, the body weight increases, and the nervous instability subsides. These symptoms, signifying an " induced remission," may indicate improvement for many days, but eventually a time arrives when the pulse rate, basal metabolism, and body weight, become stationary, or as seen on the graphic chart, the lines " straighten out." This represents the stage of maximum improvement and is the optimal point for surgical intervention. If operation is delayed beyond this point, the patient begins to regress, as shown by the graphic chart.

The operation of choice is, of course, a bilateral subtotal thyroidectomy, and it is only by ultimately reaching this stage that cure can be expected; but various factors often demand a series of operations before complete removal is possible. It is largely through experience that judgment, as to the correct procedure to be instituted in the individual case, is attained. We believe that each patient should be evaluated soon after admission and his treatment planned accordingly. If this is not done, a false impression of

the resistance of the patient may be obtained. Apparent improvement under iodine therapy may encourage ill-advised radicalism which will be reflected in the mortality statistics. While iodine undoubtedly lessens the post-operative reaction, it does not entirely avoid unfavorable reactions in well-advanced and complicated cases. We cannot, at the present time, agree with those clinics that are discarding ligation and hemithyroidectomy in favor of primary subtotal thyroidectomy in all cases. In young people, with moderately advanced disease, who react promptly to physiological rest and iodine therapy, the complete operation is the procedure of choice and is uniformly successful. For more advanced cases in older patients with high basal metabolism, who exhibit emaciation, cardiac incompetence as judged by fibrillation or decompensation, and who do not react promptly and completely to physiological rest and iodine, the choice of primary operation rests between unilateral lobectomy or hemithyroidectomy and by-polar ligation.

Hemithyroidectomy has been very successful, as judged by the post-operative reaction. If this is only moderate, the second lobe may be removed after forty-eight hours; if severe, completion of the operation may be postponed for several weeks, during which the patient shows marked improvement, as judged by gain in weight, lowered basal metabolism, and slower pulse, so that he goes through the second stage with little difficulty.

Ligation is reserved for very advanced cases. Temporary, but often remarkable improvement, is obtained, which lasts for about four months. These patients routinely return for the second stage, which may be either a subtotal thyroidectomy or hemithyroidectomy, at the end of ten weeks. Occasionally, unilateral polar ligation, followed by ligation of the opposite pole, then by hemithyroidectomy, and finally by subtotal bilateral removal, are the various steps found necessary.

Of other procedures, injection of boiling water or alcohol is of benefit as a temporary, palliative measure, but is probably only to be used in cases at the time inoperable. With cervical sympathectomy, we have had no experience. Some of the foreign clinics have reported successful results, but it would seem a much more logical procedure to attempt interruption of the sympathetic impulse by destroying the periarterial sympathetics, than by subjecting the patient to the long operation which removal of the ganglion demands.

Post-operative care holds a place of equal importance with the pre-operative preparation and operative procedure. The anoci technic is continued, if possible, until the immediate reaction has subsided, thus obviating the element of post-operative mental shock. It is surprising to note the number of intelligent patients who leave the hospital without realizing that they have undergone an operation. Water is given as soon as nausea ceases, in liberal quantities, morphine is administered at regular intervals for the first twenty-four hours, and iodine continued until the "danger period" has passed. All of these measures aid in preventing that most dreaded complication, post-operative thyrotoxicosis, which now is seldom seen. Should a

moderate toxic reaction occur, it is usually controlled by administering large quantities of fluid by mouth, rectum, subcutaneously or intravenously; by increasing the iodine; by early resort to blood transfusion; and by using the ice-bag technic.

The success or failure of any method of operative procedure is, of course, dependent upon the mortality and morbidity statistics, providing, of course, that selection of cases does not distort these figures. This consideration has been entirely avoided in our clinic due largely to circumstances. Situated in a community where ultra-conservatism, verging often on quackery, often keeps the toxic patient away from the surgeon until he is seriously handicapped, we receive probably as many of the so-called poor surgical risks as are encountered in any clinic.

The mortality statistics have here, as elsewhere, been materially reduced since the advent of iodine. Previous to 1920 our mortality in toxic cases averaged 2.77 per cent.; since 1920 we have had a consecutive series of 262 operations on patients with toxic goitre with two deaths, representing a mortality of less than 0.8 per cent. (0.76 per cent.). One of these deaths was unavoidable. It occurred in a patient fifty-four years of age, who had an extremely poor myocardium, as judged by continuous fibrillation and marked decompensation. Her death was due to cardiac failure, which probably would have resulted from any major surgical procedure. The second death was due to post-operative thyrotoxicosis following subtotal thyroidectomy in a very toxic case. Over-enthusiasm in the efficacy of iodine therapy was responsible for this error. Mature judgment should have dictated either ligation or hemithyroidectomy as the primary operation. The mortality statistics here represented are probably as good as can be obtained with the present knowledge of the nature and treatment of thyroid disease. Not until some other, as yet undiscovered, factor comes to light, can we expect to reduce it to the idealistic infinitesimal.

HYPERNEPHROMATA*

AN EXPERIMENTAL AND CLINICAL RESEARCH

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Since Grawitz first expressed his belief in the Cohnheim theory to explain the genesis of renal hypernephromata, the origin of these growths has been subjected to much intensive study. Many investigators have been led to support the original Grawitzian theory; a considerable number offer evidence in justification of their belief that the adrenal cell rests play no part in their genesis.

The several alternative theories proposed will be described later; suffice it to say here, the problem remains sub-judice.

From the clinical, as well as from the pathological standpoint, the term hypernephroma has been used in some cases to denote renal neoplasms that fulfill the characteristics of the growth originally described by Grawitz, as well as many others which have failed to fulfill these characteristics. This investigation, the results of which are described herewith, was undertaken with the idea, first, of adding pathological data that might contribute to a more exact classification of these tumors, and secondly, of proving or disproving to our satisfaction the views expressed by Grawitz.

The paper comprises, first, an analysis of the available literature on the subject; second, a résumé of the investigative work pertaining to the embryology of the adrenal glands and the kidney; third, the results of some original studies on the embryology of the adrenal and the kidney; fourth, a report on the results of some experimental work on the influence of extracts of fresh hypernephromata on the production of hyperglycæmia in rabbits, and finally, a pathological study of twenty-three tumors, from man and lower animals.

Literature.—In 1883, Grawitz published the following reasons for his belief that hypernephromata are formed from adrenal rests and described a typical one under the name "struma aberrata suprarenalis":

1. The position of the growth under the kidney capsule where adrenal rests are frequently found.

2. The characteristic cells resemble those of the adrenal cells, which do not resemble in any respect the normal kidney cells.

3. The characteristic lipoidal infiltration which is never found in the cells of the urinary tubules but is a constant feature of the adult adrenal cortical cells.

4. The possibility of a limiting capsule which sharply demarcates the growth from the surrounding kidney tissue.

5. The relation of the cells to the stroma of the tumor, which recalls in a marked

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manner the appearance of the arrangement of the cells in the fascicular portion of the normal adrenal cortex, particularly with reference to the arrangement of the cells in the columns and rows.

6. The similarity of this form of renal tumor to tumors of the adrenal gland itself.

7. The structure of these growths is typically different from the normal kidney structure.

8. The nucleolus stains differently from the nucleus. This is rarely seen in the cells of renal adenoma.

9. The finding of an entire adrenal as an accessory organ in the kidney.

LUBARSCH made mention of the occurrence of giant cells and calls attention to the fact that these cells may be present in simple hyperplastic growths of the adrenal itself.

BUSSE in his studies of the embryonic adrenal repeatedly found structures in the embryonic adrenal resembling those in the tumor. The chief trouble in the interpretation of the microscopic pictures arise from the papillary glandular cyst formation.

HANSEMANN claims that they come from adrenal rests and that they are malignant from the very beginning. He states that the true kidney adenomata are different from hypernephromata in their typical glandular structure while papillomata are characterized by the fact that they have a papillary structure throughout which is the case only in isolated parts of the hypernephromata, and, never, in the latter, reaches a typical formation. He speaks also of an endothelial adenoma and claims that these tumors may easily be confused with hypernephromata, for in many places there is certain similarity of structure.

GARCEAU says, "It is impossible to decide definitely in regard to the nature of the growth. It is evident, until some definite agreement shall have been decided upon in regard to the tumor classification that we cannot do better than to relegate these growths in a class by themselves. The fact that they develop from adrenal rests in the kidney is now so commonly admitted that there are few who deny this. It seems to be an incontrovertible fact."

DUNN in an examination of eighty cases found four kidneys showing adrenal rests. The remarkable feature in these cases was the intimate association of the suprarenal cells with renal tubules. He concluded that the epithelial abnormalities of the three types frequently described, namely suprarenal rests, adenopapillary tissue, and papilliferous cysts, had been found fairly frequently in the kidneys of the eighty consecutive cases under his study. The amount of material examined, though insufficient to afford definite statistics, he held sufficient to prove that their occurrence is by no means rare.

CHIARI supports the Grawitz idea with the following reasons: One, the situation of the tumor in the region where suprarenal rests occur. Two, that the tumor may have a definite capsule. Three, the fact that tumors of the kidney may develop from aberrant adrenal tissue and that these may become exceedingly large and give rise to metastasis. Four, the histological resemblance of the renal tumors to those of the suprarenal. Five, the pigment and fat in the cell contents.

MELOY has gone over the embryological idea of Wilson and Willis that the so-called rests are independent of adrenal development. He concludes that, from our present knowledge of these tumors, the term hypernephroma should continue until something more definite can be set forth to disprove conclusively that the tumors do not arise from the so-called adrenal rests. With the term hypernephroma we recognize a definite entity which will take a long time to replace with such names as lymphonephroma, endothelioma or perithelioma.

BENECKE found cases with adrenal tissue in its resting and proliferating condition side by side, and with it true sarcoma. He believed the alveolar form of growth to be more certainly of a sarcomatous nature than the palisade form.

KELLY is inclined to believe that the hypernephroid tumors are angio-sarcomata or peritheliomata purely from a morphological standpoint and nothing else. He considers,

however, that the morphological basis is not sufficient to classify this tumor nor indeed is the histological.

Dreissen observed that every lymphatic whose normal endothelial lining was lost was filled with one or more tumor cells which appeared to have an endothelial character. He considered that the tumor arose from the endothelium of the lymphatics. He commented particularly upon the similarity of these kidney tumors with endothelial tumors of the bones, importance of such similarities being the presence of cavities filled with blood, and capillary projections within cells arranged around it. His cases were like those of DePaoli called angiosarcomata.

DePaoli gives special attention to the cells about the dilated capillaries, the arrangement of the cells in palisade form upon the blood-vessels, and laid special stress upon the fact that between the endothelial wall of the capillaries and the cells there was no interposition of tissue. He found proliferation of endothelial cells in some of the capillaries which projected into the lumen. Some of the endothelial cells appeared to be multinuclear. There was hyaline degeneration of these cells arranged along the capillaries and those of the connective tissue. The blood-vessels formed the framework of the tumor.

Sudeck denies that the growth has anything to do with adrenal rests. It is his opinion that they are adenomata of the kidney. He describes their origin as from the epithelium of the uriniferous tubules. He claims he was able to trace the development from the proliferation of the urinary tubules which from the beginning showed an atypical character. He states that a network of tumor cells is surrounded by capillaries without being separated from the wall of the capillaries by connective tissue. He rejected the idea that there was fatty infiltration and called it a fatty degeneration.

Birch-Hirschfeld calls attention to the fact that the alveoli present remind one of the glomerular alveoli since the cells which lie directly on the capillary walls without the formation of the renal membrane propria, may take on a more cylindrical form. He called these tumors hypernephromata.

Manasse describes an angiosarcoma which he calls a perivascular sarcoma. Also a venous endothelioma and an endothelioma arising from lymph spaces. All these tumors were very similar in appearance.

Kelynack gives a very exact description of the microscopic character of these growths and is rather inclined to believe that they are of renal adenomatous formation. The whole question of adenomatous growth met with at all periods of life requires a most thorough investigation, but until whole specimens of a renal growth are submitted to thorough microscopic investigation, our knowledge of this important and probably very complex adenomatous growth will not advance very far. To the mere naked eye the adenomatous formation of the growth often resembles the sarcomata.

Borst refers to the alveolar sarcoma-like structures and the difficulty of separating these growths from the other growths of the kidney. He also cautions against mistaking these suprarenal growths for certain renal tumors which belong to the endotheliomata or peritheliomata, and observes that many authors consider these angiosarcomata and peritheliomata as of suprarenal origin.

Hektoen and Riesmann admit the impossibility of classifying these growths as carcinomata or sarcomata. Morphologically they sometimes deserve the name of one, sometimes the name of the other. Histogenetically the determination would rest with the nature of the cells of the adrenal gland. The authors decline expression of opinion.

Adami claims that whereas aberrant adrenal tissue is from its heterotopic nature more prone to become blastomatous, and whereas it may well be that a large number of the kidney tumors of this type are hypernephromas, others are nephromas. When a tumor of the kidney shows a special liability to form tubules rather than solid cell masses, we would suspect a renal rather than an adrenal origin. The two organs adrenal and kidney are embryologically so closely related that the tumors arising from these homologous tissues must possess closely related characters. He defines mesothelioma:

(1) A tumor arising from such tissues or portions of organs of mesothelial origin, which possess in the adult state lepidic character.

(2) When typical and growing slowly it is purely of the adenomatous type.

(3) When atypical or more anaplastic and growing rapidly, it reverts first to an alveolar sarcomatous type and later to a structure or want of structure which renders it undistinguishable from a round or even a short spindle-cell sarcoma.

(4) The tumor when it takes on its undifferentiated type affords metastasis of a sarcomatous order. The primary growth in general, if studied exhibits indications of the successive stages through which it has passed from the adenomatous to the sarcomatous form of growth.

JELLE presents six tumors which, although all of these possessed a capsule, cordons and clear cells, rich in fat, he does not think sufficiently established a suprarenal origin. In regard to the fat content of the cells, he considers it impossible to differentiate microscopically the fat of hypernephromas from that of cancer of the kidney, either by polarization or staining. He concludes, in spite of the contradiction of Grawitz on the one part, and of Stoerk on the other, that it is impossible for us to decide from the insufficient histological groups the origin of the tumors. If he were required to pronounce definitely on the six cases which he presents, he could estimate that only the first two could be considered as tumors of suprarenal origin.

ALBARRAN and IMBERT describe a large cell under the microscope with clear protoplasm, characterizing a tumor which, when benign they call an adenoma, when malignant an epithelioma. They both present the same microscopic appearance. They call this tumor adenoma and epithelioma with clear transparent cells in consequence of the transparent look which the cells have when the abundant fat which they contain has been dissolved out in the process of the mounting. The authors assert that these tumors may have a double origin, namely, from the renal epithelium and also from aberrant suprarenal rests in the kidney.

BURKHARDT is of the opinion that malignant tumors of the adrenal in the kidney develop from a pure adenomatous growth of adrenal tissue, but not directly from misplaced adrenal elements. In his opinion it was plainly seen how the stromatous tissue was transformed into a solid cellular, papillary and alveolar or irregularly diffuse growth, in places corresponding to the relations that are found in the malignant adenomata. This irregular, many layered, alveolar structure is continued into a diffuse cell growth or it forms larger alveolar cell complexes. The decision according to Burkhardt depends upon two points: one, what principle tumors should be classified and, two, what relation the adrenal holds both in embryonic and physiologic relations. He is inclined to look upon these tumors of the kidney as analogous to malignant tumors of other glandular organs which are ordinarily designated as carcinomata. Tumors of the adrenal show peculiarities found only in the carcinomata, that is, cell nests and papillary growths of cells. He believes they should be considered carcinomata of this gland as we do those of other glands.

WRIGHT put forward the view that the appearance usually labelled hypernephroma was a product of the malignant change of the renal tubules and one of the ways in which they react to a neoplastic stimulus, because it seemed to him that this is a more useful conception of the disease than the one which holds it to be an isolated phenomenon arising from the capricious and somewhat belated growth of a misplaced tissue-remnant.

STOERK claims that no kind of convincing agreement exists between hypernephrogenic and nephrogenic tumors. The different forms of Grawitzian tumors are shown histologically as varieties of one and the same type. He further states that the Grawitzian tumors of the kidney are of renal origin, and that the blastoma tumors are characteristic of children while the Grawitzian tumors are found mostly in the second half of life. This tumor which is found in the second half of life is quite intelligible in relation to the origin in contraction processes. The tumors under discussion should be designated adenomata, papillary cystomata, or carcinomata of the kidney after the Grawitz type. Papil-

lary formations which so frequently appear in the Grawitzian tumor are a strong argument against their adrenal origin. The type of tumor apparently solidly alveolar throughout can be recognized by careful examination as a tubular as well as a papillary growth. The hypothetical order of development is probably first, kidney contraction: second, papillary cystoma, and third, Grawitz tumor.

ZEHBE is of the same opinion as Stoerk. Zehbe objects to the Grawitz hypothesis and suggests that they arise in compensatory hypertrophy of the renal tubules.

WILSON and WILLIS claim that most if not all so-called adrenal rests are probably of Wolffian origin. There is much evidence that the so-called hypernephromata do arise from islands of nephrogenic tissue. Such tissue is sometimes present in the adult kidney and appears capable of forming tumors of the non-infiltrating, mixed cordon, tubular papilliform, and sarcoma type so characteristic of the so-called hypernephromata.

SISSON agrees with Stoerk and Wilson that the renal tumors have no relation to the suprarenal gland.

STRONG studied the congenital tumors of the kidney and their literature. He concludes that they are of embryonic origin. The term carcinoma cannot be applied to them as the adenomatous type is evident and as the epithelial elements do not take origin from the developed glands of the kidney. Histogenic comparison shows that these tumors resemble the embryonic Wolffian body. There is a continuous system of tubules and their derivative cell masses throughout the tumor. The cell masses are derived from the tubules by retrograde metamorphosis. Histological characteristics vary with the age of the part. The pelvic region is oldest, showing complete differentiation of the mesenchyma and epithelium. The metastases are youngest and show an embryonic condition where all other cells are alike. Bilateral tumors are coincident and not metastatic. Metastasis may occur through the lymph stream as well as through the blood stream.

MCFARLAND, "That aberrant fragments of adrenal tissue occur is undisputable; that hypernephroma develops from them seems to us most reasonable."

HALL states that in general hypernephromata, the most common of primary renal neoplasms, is to be regarded as a true and peculiar species, well worthy of a place of its own and quite distinct from carcinoma and sarcoma.

EWING concludes "that the presence of adrenal rests in the kidney is fully attested, although they are less frequent than many have supposed. It also appears that certain tumors arise from these rests, although clear descriptions of their structure has not been fully given. Finally, recent studies have demonstrated that a large proportion of the reported hypernephromas are renal adeno-carcinomas."

A survey of the voluminous literature pertaining to hypernephromata reveals a wide variance in opinion concerning their genesis. The following theories have been propounded:

1. That they originate in adrenal cell rests.

2. They are alveolar sarcomata having nothing to do with cell rests.

3. That they are endotheliomata which take origin from the endothelial lining of perivascular lymph-spaces.

4. That they are classified, if benign, as adenomata, if malignant, as carcinomata.

5. That they develop from the endothelial cells lining the blood vascular spaces.

6. That they are derived from the epithelia lining the uriniferous tubules.

7. That they originate from islands of embryonic nephrogenic tissue.

Embryology.—Many embryological studies have been made in the attempt to demonstrate the developmental means whereby displaced cells of adrenal

origin might come into structural relationship with the adult kidney, the obvious purpose of such studies being to prove or disprove the Grawitzian theory on embryological grounds.

We will give in brief résumé the modern conception of the embryological development of the adrenal glands and kidney, together with some original observations having to do especially with the physical relationship existing between the anlagal cells. The latter comprise studies of human and pig embryos of an age when incomplete cellular differentiation permitted visualization of the compotent cells in their relationship to each other.

Adrenal Gland.—AICHEL states that "when the suprarenal body first appears, it is in close relationship to the Wolffian body. It arises from the proliferation of mesoblastic cells at the ends of the invaginations of the mesothelium lining the body cavity. This primary relation with the Wolffian body is subsequently lost and the adrenal becomes in close proximity to the kidney."

BAILEY and MILLER, in referring to the cortical substance, state that "the cortex is of mesothelial origin. In embryos of five and six mm. the mesothelium at the level of the cephalic third of the mesonephros proliferates and sends buds or sprouts into the mesenchyme at each side of the root of the dorsal mesentery. These sprouts soon lose their connection with the parent mesothelium and unite with one another to form a rather compact mass of epithelial-like cells ventro-lateral to the aorta. Frequently the two masses fuse across the median line ventral to the aorta. They constitute the anlagen of the cortical substance of the two suprarenal glands. From the fact that in the lower forms they remain separate from the medullary substance and lie between the urinary organs, they are known as inter-renal organs."

AREY states that "the suprarenal gland has a double origin. The cortex is derived from mesodern, the medulla from chromaffin tissue. In an embryo of 6 mm. the anlagen of the cortex begins to form from ingrowing buds of a peritoneal mesothelium; this proliferation occurs on each side of the mesentery near its root. At about 9 mm. the paired glands are definite organs, and their vascular structure is evident. The anlages of the suprarenals early project from the dorsal wall of the cœlom, between the mesonephros and the mesentery; here they become relatively huge organs. The differentiation of the cortex into its three characteristic layers is not completed until between the second and third years. The inner reticular zone is formed first, the fasciculate zone next and finally the glomerular zone appears during the third month."

"The chromaffin cells of the medulla are derived from the cœliac plexus of the sympathetic system. In embryos of seven weeks when the cortex is already prominent, masses of these cells begin to migrate from the median side of the suprarenal anlage to a central position. Such penetration probably continues until after birth. The primitive chromaffin cells are small and stain intensely."

PATERSON states that "the cortex and medulla of the suprarenal capsule are derived from different sources. The cortex is developed first. It is formed in the first month of fetal life by a series of fetal buds which grow into the subjacent embryonic mesoblast from the cœlomic epithelium, on each side of the root of the mesentery. These buds coalesce and give rise to a mass of cells underlying the cœlomic epithelium. The mass forms a longitudinal ridge, the suprarenal ridge, in a position between the Wolffian body and the root of the mesentery. The medulla is derived from the main sympathetic cord. Subsequent to the formation of the cortex and the suprarenal ridge a stream of cells passes in to the base of the ridge and gives rise to the medullary portion of the capsule."

LEWIS and STOHR are of the same opinion. They state that "the cortex appears first and is formed from cells which develop as buds of the cœlomic epithelium growing into the mesenchyma on either side of the root of the mesentery medial to the Wolffian

bodies. In embryos of 8 to 12 mm. the buds or cords have become detached from the peritoneal epithelium. Meanwhile cells from the sympathetic ganglion grow ventrally along the medial side of these masses."

WIEMAN found in his investigations that "in 9 mm. embryos the suprarenal glands are not recognizable as distinct organs, but consist of a thickening in the mesenchyma on either side of the root of the mesentery, forming a pair of broad ridges projecting into the body cavity from the dorsal body wall. Anteriorly these suprarenal ridges are continuous with the dorsal portions of the pleuro-peritoneal membranes while posteriorly they blend with the genital ridges. Laterally each is separated from the mesonephrosi by a distinct groove. The ridges are made up of mesenchyme which shows no evidence of differentiation. The ramus communicans which is really the direct ventral communication of the latter loses itself in the mesenchyme of the suprarenal region. It seems to be accompanied by nerve cells. In 12 mm. human embryos the suprarenal glands are distinctly marked off from the surrounding tissues. On the median side in close contact are bundles of nerve fibres and ganglionic clumps."

Kidney.—The development of the kidney was first described by Kupffer and later his views were supported by Balfour, Keibel and Huber.

BAILEY and MILLER state that "the kidneys are the third set of urinary organs to develop. They assume the function of the mesonephrosi as the latter atrophy, and constitute the permanent urinary apparatus. Each kidney is derived from two separate anlagen which unite secondly. The epithelium of the ureter, renal pelvis and straight renal tubules (collecting tubules) is derived from the mesonephric duct by a process of evagination. The convoluted renal tubules and glomeruli are derived directly from the mesenchymal and in this respect resemble the mesonephric tubules and glomeruli."

PATERSON sums up the competent parts of the urinary system as follows: "The metanephric duct produces the ureter, pelvis of the ureter, calyces, and collecting tubules of the kidney. The renal vesicles give rise to the tubular system of the kidney glomeruli, primary convoluted tubules, looped tubules of Henle, and the secondary convoluted tubules. The nephrogenic tissue also produces the interstitial tissue and capsule of the kidney. The resemblance between the development of the kidney and ureter and the development of the mesonephros is too striking to escape notice. The kidney is, at first lobulated but in abnormal cases only is the kidney lobulated in the adult."

LEWIS and STÖHR state that "the kidney developed after the Wolffian body has been formed. It arises in two parts, one of which is an outgrowth of the Wolffian duct. The other is a mass of dense mesenchyma surrounding this outgrowth and said to be derived from the posterior nephrotomes. Both parts are mesenchymal."

PIERSOL states that "the development of the definite kidney in mammals begins as a pouch-like outgrowth from the posterior wall of the Wolffian duct a short distance above its termination in the cloaca. In man the renal diverticulum makes its appearance during the fourth week, at which time the embryo measures from 6 to 7 mm. in length. At first short and wide, the stalk of the pyriform sac soon becomes tubular, growing upward and backward into the mesoblast of the posterior body wall. The stalk rapidly elongates and terminates above in a blind club-shaped extremity which after a time lies behind the upper atrophic segment of the Wolffian body. The tubular duct becomes the ureter and its dilated end segment the renal pelvis. The latter is surrounded by a sharply defined oval area of compact mesoblast that is intimately concerned in the production of the convoluted kidney tubules and hence is termed the renal blastema. From the ventral and dorsal wall of the primitive pelvis which is compressed from before backward, a number of hollow sprouts grow into the surrounding mesoblastic stroma. Each is a short cylinder which terminates in a slight dilatation. At first a few of these sprouts increase rapidly in number as well as in length and by repeated dichotomous division gives rise to a system of branching canals that later are represented by the straight collecting tubules of the kidney. Concerning the origin of the remaining portions of the uriniferous tubules two opposed views obtain. According to the one all parts of these canals

develop as direct continuations of the outgrowths from the primitive renal pelvis. According to the others, the convoluted tubules (from their beginning in the capsule to their termination in the collecting tubules within the medullary ray) arise independently within the renal blastema, and, secondarily, unite with the duct system from the pelvis to complete the canals. The careful studies and reconstructions of Huber leave little doubt as to the correctness of the latter view, which, moreover, with the principle observed in the development of the pronephrosis and the Wolffian body, in which the tubules and the duct join subsequent to an independent formation. The attenuated proximal end of the convoluted tubule, for a short time solid and in close relationship with the anlage of the glomerulus, soon becomes a sickle-like process which gradually incompletely surrounds the vascular tuft and later expands into the characteristic capsule. With the continued growth of the tubules their tortuosity becomes very marked, the loop of Henle early becomes a conspicuous feature of their course. By the third month the formation and grouping of the tubules have progressed to such extent that the surface of the young kidney exhibits the outlines of the individual lobes composing the organ. This lobulation is retained until some months after birth. In addition to the convoluted tubules the vascular and supporting tissues are derived from the renal blastema, the condensed peripheral part of which becomes the fibrous capsule of the kidney. As the latter assumes the rôle of active excretory organ the Wolffian body undergoes atrophy, with the exception of such parts as are concerned in the development of the sexual ducts."

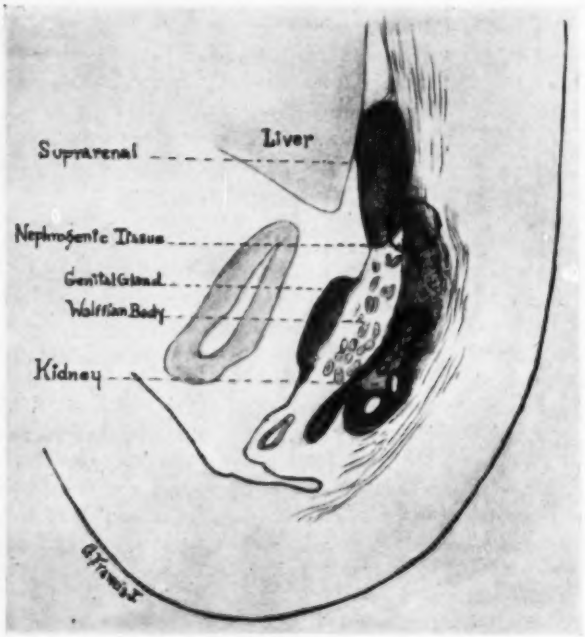

FIG. 1.—Longitudinal section of a 16 mm. human embryo. (Modified after Wilson and Willis.)

Original Studies.—The original studies were made with the hope of obtaining cross-sections of embryos at an age when the anlage of the cortical substance of the suprarenal gland and metanephros are to be found at the same level. Of the specimens studied, including pig embryos of 9, 12, and 19 mm., and human embryos of 7, 12 and 16 mm., respectively, the 16-mm. human embryo alone revealed the two anlages in close proximity. In this specimen cross-sections made at the upper pole of the mesonephros disclosed the presence of the component cells of this structure together with the cortical substance of the suprarenal gland in the closest proximity and at a fairly early developmental stage.

The illustration (Fig. 1), which is a modification of the one presented by Wilson and Willis, shows the approximate level at which these sections were

cut, namely at the level of the upper pole of the metanephros. The illustration (Fig. 2) shows the relation of the respective anlagen in cross-section at this level. In describing the cross-section and taking the aorta as a fixed point, we find ventro-laterally to it a collection of cells in the mesenchyme representing the cortical substance of the suprarenal gland. The identification of the latter structure is dependent upon the characteristic cortical cells, with a somewhat irregular outline and a large nucleus. Scattered between these cells, are imperfectly formed blood sinuses which are identified by the presence of endothelial cells. The arrangement of the above-described cells into strands is the typical finding in the adrenal anlagen. Ventro-lateral to these suprarenal cells is the mesonephros and genital ridge, with the metanephros placed in a lateral position. In this section as is shown by the illustration, it is difficult to determine the limits of the cortical cells; there is no definite limiting tissue. When studied under high magnification a very narrow band made up of young connective-tissue cells is deflected separating these two anlagen, but the separation in places is very poorly defined, being effected by only one or two connective-tissue cells.

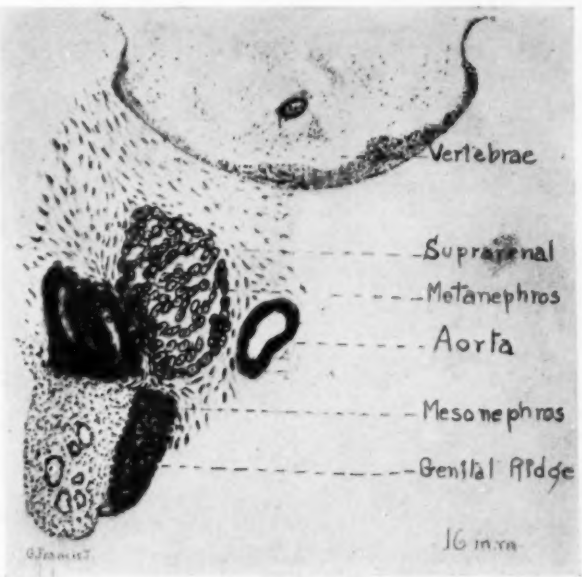

FIG. 2.—Cross-section of a 16 mm. human embryo at the region indicated by a circle in Fig. 1.

The above findings would seem to justify on embryological grounds the belief that certain cells of the developing adrenal gland might become included in the developing kidney (metanephros). Our observations suggest the possibility of displacement in the mesenchyme of suprarenal cells just before any differentiation of the metanephros and suprarenal ridge. It would seem, too, that these structures are sufficiently adjacent to each other in the early stages of their differentiation to make cellular inclusion possible. In the absence of the actual demonstration of such inclusions during embryological development the genesis of adrenal cell rests within the adult kidney is mere conjecture. We may assume on hypothetical grounds that cellular differentiation in the metanephric area may take on a character not unlike that which takes place in the suprarenal area. It is mere conjecture, but nevertheless within the bounds of possibility, to assume that certain mesenchymal cells destined to form the metanephros may develop the structural characteristics of adrenal

cells, the latter being represented by adrenal cell rests commonly found in the adult kidney.

Chemistry.—Comparative studies of various hypernephromata have revealed a certain consistency in the nature and proportion of their chemical constituents. The results of these investigations although yielding insufficient information for use as the basis of a more exact classification than can be made upon embryological and upon pathological grounds, are extremely interesting.

GATTI estimated the lecithin content of hypernephromata and found that it approximated that of adult suprarenal gland. He estimated it to be 3.4735 per cent. BEEBE performed qualitative analyses upon watery extracts of hypernephromata and demonstrated the presence of tryptophane, proteoses, glycogen, leycine, and tryosine. LOHLEIN made the observations that the double refractive properties of certain fat-like substances found in diseased states of the kidney and adrenal gland are entirely dissimilar. GRIER and WELLS in attempting to recover adrenalin from renal hypernephromata were unable to detect the presence of even the slightest trace of this substance. WEGLEIN, however, claims to have found adrenalin in tumors originating from adrenal gland. CROFTAN states that watery extracts of adrenal hypernephromata and fresh normal suprarenal gland tissue have following properties:

FIG. 3.—Tumor from which the fresh tissue was removed for the chemical studies.

(1) Injected into the body of a dog or rabbit, producing glycosuria.

(2) Possessing the power of converting starch into dextrose and maltose and this power of the extract lost on boiling.

(3) Causing the blue color produced by iodine in starch solution to disappear.

HALL, referring to the chemistry of hypernephromata, states that although the histologic structure of the tumor is most variable, the several varieties can hardly be mistaken for anything else for they have a distinctive chemical composition. A high proportion of cholesterin, lecithin and fat is always present. The reducing power of the watery extracts of hypernephromatous tissue on a starch iodine solution is so striking as to make the test applicable in the operating room. He was unable to produce a similar reduction in color in 35 cases of carcinoma and sarcoma.

WELLS presents a table showing the percentage content of fats and lipoids in hypernephromata as compared with normal adrenal, carcinoma of the gall-bladder, carcinoma of the breast and secondary carcinoma of the liver.

TABLE I

Substances	Normal adrenal	Hypernephromata				Carcinoma of gall-bladder	Carcinoma of breast	Sarcoma secondary in liver
		1	2	3	4			
Ether–Solvable material	36.3	28.0	33.0	38.4	85.0	8.6	21.4	14.5
Cholesterol per cent., total dry weight	7.6	4.6	6.7	8.7	0.5	2.2	0.9	1.6
Cholesterol per cent., dry fat-free sub.	11.9	6.4	10.0	14.0	3.3	2.4	1.2	1.9
Cholesterol per cent., ether–sol. sub.	20.6	16.9	20.4	22.9	0.7	26.1	4.3	11.0
Lecithin per cent., total dry weight	11.8	6.0	9.0	8.3	2.0	1.7	0.7	6.2
Lecithin per cent., fat-free sub.	18.4	8.3	13.4	13.4	13.3	1.9	0.9	7.3
Lecithin per cent., ether sol. sub.	33.0	22.7	27.5	2.4	2.4	20.0	3.0	39.8

We report herewith several observations on the influence of injections of watery extracts of hypernephroma on the sugar content of the blood. The extract was made from fresh tumor tissue kindly furnished us by Dr. B. A. Thomas. The following method devised by Croftan was used:

(1) Eighty gms. fresh hypernephroma tissue.
(2) Mash to fine pulp in mortar.
(3) Extract with 200 c.c. of distilled water.
(4) Filter through gauze.

A specimen of blood for sugar estimation was taken from the ear veins of four rabbits which had been fasting for sixteen hours. Following this 50 c.c. of the watery extract of the tumor (hypernephroma) was injected into the lumbar region of each of these rabbits. Specimens of blood were extracted from the ear veins of each of these rabbits, 45 minutes, 2 hours, and 24 hours, respectively, after the injections.

The following table shows the percentage sugar content of the blood before and after these injections:

TABLE II

Time blood was taken	Rabbits			
	1	2	3	4
Before injection	0.111	0.107	0.109	0.123
45 minutes after injection	0.130	0.090	0.118	0.136
2 hours after injection	0.134	0.106	0.112	0.131
24 hours after injection	0.115	0.093	0.105	0.153

Numbers equal mg. of sugar per 100 cc. of blood.

The above tabulated estimations of blood sugar in rabbits 1, 3 and 4, after injection of the watery extract of hypernephroma tissue are quite in

accord with the urinary findings made by Croftan. It would seem from these experiments that the maximum effect is within the first two hours after injection. The failure in No. 2 rabbit to show any rise was probably due to delayed absorption. The results in our work in producing hyperglycæmia after injection of this extract and the results of Croftan in producing glycosuria are very instructive. The acceptance, however, of this finding as specific for hypernephromata will depend upon more extensive varification, especially along comparative lines with other tumors and normal tissues.

It would seem when one compares the respective chemical findings of hypernephromata with those from the cortical cells of the adrenal that there is a striking likeness, especially with respect to the lecithin content per cent. and the per cent. content of fat, lipoids and glycogen. The " specific tests " for carbohydrate content of these tumors seem helpful in the diagnosis. Koerbers, however, investigated these tests and was unable to corroborate them.

CASE REPORTS

The case reports include those from the autopsy records at the University of Pennyslvania since 1902. In this report no history or reference will be given to the clinical aspect of the respective cases.

CASE I.—No. 162. R. V., white female, sixty-five years of age. Died July 1, 1904.

Findings.—Right kidney. Weighs 610 gms. It was the seat of a tumor mass. On cut section practically no kidney tissue remained, but the tumor mass showed two generally rounded foci of softening in the interior of which was a dark, bloody fluid. The walls of these cavities are rough, ragged and somewhat red in color. The tumor about these foci was pale, arranged somewhat in lobules, and did not bleed on section. Interior to these two general masses was a necrotic area which embraced, anteriorly, the abdominal aorta. The right ureter showed no abnormality until it reached almost to the tumor mass. Then it became slightly dilated and congested just before it disappeared into the tissue.

The right adrenal was large and on cut section showed involvement by the tumor tissue.

The left adrenal was large, firm, the periphery was yellow and the interior pale with a line of dark red in between them.

Liver.—Weighs 970 gms. It was very hard and had a leathery feel. Over the anterior surface were a number of small, elevated, pale nodules bulging through the capsule. On section the internal part of the right lobe contained a large, necrotic tumor focus. Numerous other smaller ones were found throughout the liver.

Left Pleural Cavity.—Over the parietal pleura of both sides were found numerous small pedunculated nodules varying from 1 to 2.5 cm. in diameter. On cut section these were pale and yielded a milky fluid.

Left Lung.—Weighs 615 gms. It was adherent anteriorly along the parasternal line and at the apex. It was covered over with many elevated white nodules varying from minute size to 4 or 5 cm. in diameter. Cut section showed the nodules to have a pale, yellowish-white periphery and some of them had ragged, degenerated interiors, especially the larger ones. There were fewer nodules in the interior than there were on the surface. The right lung was the same as its fellow.

CASE II.—No. 2137. C. H., white male, forty-three years of age. Died 1906.

Findings.—Left kidney. At the lower pole of the left kidney apparently separated by a capsule from the renal substance was a rounded tumor 3.5 or 4 cm. in diameter protruding beyond the end of the kidney. It was, when fresh, of a light reddish-yellow

color and of a soft, fleshy consistency. At the upper end of the pelvis invading the renal substance was a small nodule about 1 cm. in diameter well circumscribed but not encapsulated.

Eye.—A small tumor was found on the iris of the left eye.

Abdomen.—A number of subcutaneous nodules were found in the abdomen and chest wall. Some of these disappeared apparently spontaneously. Multiple tumors within the intestines were found, one being about the size of a walnut, one in the ileum and two in the colon. Each was about the size of a small walnut. The one in the small gut was dark red, hemorrhagic, soft and appeared necrotic.

CASE III.—No. 1589. M. C., female, fifty-one years of age. Died July 14, 1907.

Findings.—Right kidney. The right kidney weighed 2655 gms. The organ had retained its shape fairly well. It was diffusely infiltrated with tumor masses to such a degree that little of the kidney tissue remained. At one pole there appeared two openings about 2 cm. in diameter which probably represent the remains of the pelvis. The configuration of the structures in the immediate neighborhood serve to confirm this fact. Near the capsule there were seen several small yellowish, rather soft areas. The portion of the organ farthest removed from the pelvis had undergone softening and disintegration.

CASE IV.—No. 2047. E. K., male, sixty-eight years of age. Died April 12, 1908.

Findings.—Left kidney. The left kidney weighs 110 gms. The upper portion was markedly enlarged beneath the capsule. Over the upper portion were numerous elevated, yellowish-white areas irregular in size. On cut section this enlarged portion was seen to be made up of a central tumor mass surrounded by stratified kidney substance from which in places it was separated by bands of connective tissue. The cut surface of the new growth was yellowish-white, semi-translucent. There were mottled opaque yellow areas of degeneration and points of hemorrhage. The tumor was more or less lobulated. The renal vein was distended by a yellowish-white mass which is adherent to its walls. The inferior vena cava from the point of entrance of the left renal vein upward to the liver was occupied by a mass of tissue similar to that found in the kidney. This mass was adherent in places to the wall of the vein.

Left Lung.—The left lung weighs 460 gms. It crepitated well except in the posterior portion. There it was of a yellowish-gray color, mottled with black, and dark red in the posterior portions. In the lateral parts of the lower lobe there was an elevated yellowish-white area about 1 cm. in diameter which on section was yellowish-white in color, moderately firm, and on scraping with a knife became pitted. On cut section of the posterior portions of the lung the surface was bright red in color and on pressure exuded frothy blood-tinged fluid.

Right Lung.—The right lung weighed 380 gms. It was similar to the left and showed a metastatic growth similar to that seen in the lower lobe of the left lung.

CASE V.—No. 3783, female, white forty-five years of age. Died January 12, 1912.

Findings.—Adrenal. There were no findings given referably to the gross pathology of this organ. The microscopic findings showed the blood-vessels to be filled with blood. The capsule was about normal thickness. The cells of the cortex were markedly vacuolated and the nuclei were stained well. The cells of the medulla in some portions showed yellowish pigment. At one end of the section is a small new growth extending from the medullary portion to the surface. It was bound by fibrous tissue and contained irregularly arranged masses of cells. The type of cell was an irregular oval one. Sometimes it was branched and arranged along a wall of fibrous tissue. The cytoplasm was distinctly pink surrounding a well-stained nucleus. The cells gradually became of normal size and arrangement as one went toward the normal tissue.

CASE VI.—No. 3818, white, male, forty-eight years of age. Died March 2, 1912.

Findings.—Adrenal. There were no findings given referable to the gross pathology of this organ. The microscopic findings showed the capsule was very much thickened and the cells very much vacuolated. A well-defined rounded area was seen in which the

cells were arranged in alveolar spaces of fibrous tissue perpendicular to the wall. These cells were well stained and contained vesicular nuclei.

CASE VII.—No. 3824, colored, male, fifteen months of age. Died March 14, 1912.

Findings.—Adrenal. There were no findings given referable to the gross pathology of this organ. The microscopic findings showed the cortex was injected with blood-vessels. The cells were granular and vacuolated. The nuclei were well stained. The medulla was composed of alveolar spaces of fibrous tissue filled with large irregular cells with hyperchromatic nuclei. These appeared to be arranged perpendicular to the alveoli.

CASE VIII.—No. 4012, white, male, fifty-one years of age. Died August 28, 1912.

Findings.—Left kidney. Weighed 900 gms. On the anterior surface of the lower pole there was a definite nodular mass, firmly adherent to the kidney and continued within the kidney substance. The perinephric fat was firmly adherent to the tumor of the kidney. This tumor and kidney when cut showed the tumor had almost completely replaced the kidney tissue, especially below the midline. The tumor mass was of a yellowish-pink color. Friable portions are present which have undergone colloid degeneration.

Right Lung.—Weighed 600 gms. There is on the external surface of the upper lobe a small nodule evidently within the pleura. On cross-section it appears white and measures 3 mm. in diameter.

CASE IX.—No. 4447, white, male, fifty-five years of age. Died April 3, 1914.

Findings.—Left adrenal. Measured 7 x 5 x 4.5 cm. It was freely movable over the kidney and contained two nodules which measured about 3 x 2 x 2 cm. They were moderately firm in consistency and on section had a yellowish tinge.

Left Kidney.—Measured 19 x 13 x 11 cm. It was irregularly pyriform with the apex downward. The surface is irregularly nodular and lumpy. The areolar tissue nearby contains several nodules like those found in the lung. The kidney itself was large occupied by similar nodules.

Renal Vein.—The renal vein on the left side was 3 cm. in diameter and contained a soft, yellowish-white, gelatinous material. This mass extended into the inferior vena cava, seemingly completely obliterating it.

Right Adrenal.—Measured 6 x 5 x 5 cm. Springing from the cortex and extending into the medulla were white nodules from 1 to 1.5 cm. in diameter.

Pancreas.—Measured 21 x 4 x 1.5 cm. Two nodules of a yellowish-white color, one of them 5 mm. in diameter, was present in the substance projecting into the peritoneum. The organ cut with increased resistance. It had definite lobulations which were separated very slightly to widely.

Liver.—Measured 4 x 20 x 6 cm. The inferior surface of the right lobe bore a solitary umbilicated white nodule 8 mm. in diameter.

Left Pleura.—This was studded by fairly numerous nodules. They were gray-white and projected markedly above the surface.

Right Pleura.—This showed numerous nodules like those discovered in its fellow.

Left Lung.—The pleura was elevated by a great number of firm, umbilicated, reddish-yellow nodules from 2 to 2.5 cm. in diameter. They were sharply circumscribed, gray-white and on section were found to be conglomerated into large masses.

Right Lung.—It was like its fellow on the opposite side.

Lymph-nodes.—The mediastinal lymph-nodes were markedly enlarged, hard, white and nodular. The largest measured 6 x 4 x 3 cm. They were located largely on the right side close to the apex of the lung. Immediately above its bifurcation the inferior vena cava contained a mass 3 x 2 x 2. It lay more toward the right common iliac vein than toward the left. It could be traced into one of the right lumbar veins which apparently entered the fourth lumbar vertebra. The body of the vertebra contained loose granular tissue. The bony material was largely replaced by a lobulated gray-white, semi-gelatinous and homogeneous material. The mass penetrated outward through the peritoneum in such a way as to erode into the left common iliac vein which contained at a distance

of 3 cm. from its junction with its fellow a second mass which measured 2 x 1 x 1 cm. This occluded the greater part of the lumen and was attached to the wall.

Case X.—No. 4562. M. J., white female, fifty-five years of age. Died September 7, 1914.

Findings.—Intestines. Three and one-half feet above the ileo-cæcal valve there projected into the lumen of the intestine two polypoid growths like thick buttons. They appeared to be swinging on short, delicate pedicles. In transverse diameter they were a little less than 2 cm. in thickness. These were separated from each other by about 1.5 cm. At the base of the upper one a third small growth of the same type was beginning to project from the submucosa. These growths were of a soft, fleshy consistency covered with normal mucosa which was amply stained with bile.

Right Kidney.—Weighed 300 gms. It was of irregular shape as a result of the diffuse yellow growth occupying the central portion and leaving the two poles relatively free. This tumor of irregular outline was 8 cm. in diameter. The growth projected into the kidney substance beneath the capsule in the form of firm nodules. It was soft and on section sharply defined borders separated it from the adjacent kidney tissue. The central gelatinous portion was apparently necrotic. Several large blood-vessels passed throughout this growth. The pelvis showed penetration of the growth in the form of a gelatinous substance beneath the mucosa.

Left Kidney.—Weighed 180 gms. On the posterior surface there were several, small, bulging tumor nodules.

Left Lung.—Weighed 600 gms. It showed many firm tumor nodules. Many of these range from a few mm. to 1 cm. in diameter beneath the pleura. The tumors were not found in the interior of the lung. They were limited to the subpleural region and were more numerous at the lower pole.

Right Lung.—Weighed 650 gms. Like its fellow except that smaller tumor nodules could be felt through the lung substance. In the posterior portion of the upper lobe there was a large growth irregular and reddish-yellow in color and about 10 cm. in diameter. It was adherent to the parietal pleura penetrating through the latter and between the ribs and the muscles of the back just within the internal border of the scapula.

Case XI.—No. 4782. F. S., white male, fifty-eight years of age. Died April 15, 1915.

Findings.—Left adrenal. Measured 6 x 2.5 x 2 cm. At its upper pole there was a round, well-circumscribed area which was soft and about the size of a hazelnut. On cut surface it was an even golden brown.

Case XII.—No. 4956. T. G., white male, forty-eight years of age. Died October 17, 1915.

Findings.—Right kidney. On its greater curvature it had one large cyst and at its upper pole presented a triangular mass apparently of new tissue substance. This was raised above the surface of the kidney. Upon section this had a fleshy appearance and resembled very closely the adrenal.

Case XIII.—No. 5067. M. J. S., white male, fifty-five years of age. Died February 23, 1916.

Findings.—Left adrenal. This was about the size of a goose egg, somewhat nodular and apparently the size of a tumor which was soft, friable and which was limited to the organ, not showing any penetration to the surrounding fat. This tumor mass was not attached in any way to the kidney.

Case XIV.—No. 5152. E. B., white male. Died April 9, 1916. Age, fifty.

Findings.—Heart. In the left auricular ventricular septum was a firm, grayish-yellow bulging, the size of a pea and a similar somewhat smaller bulging in the pectinate muscles of the left ventricle. In the right upper cavity which usually contains a goose-fat clot, there was near the apex a nodular, white tumor mass somewhat larger than a hazelnut. There the tumor was moderately firm. Its cut surface was an even, white color. The valve leaflets were quite smooth except at the margin of the mitral

and tricuspid valves which were somewhat thickened, whitened and roughened. The small nodular swelling described in the septum extended practically through this structure.

Left Lung.—Weighed 900 gms. The lung was found to be adherent in places. The adhesions were due to small and large whitish nodules which projected from the surface of the organ. At the base a whitish soft tumor bound the lung to the diaphragm. The pleural surface was smooth and from it numerous whitish-gray nodules irregularly projected. The lung had a nodular feel. The cut surface was uneven. It showed numerous grayish-white, irregular shaped tumor masses. The largest was situated in the basal lobe and was 4 cm. in diameter. The left parietal pleura was studded with about a dozen of the tumor masses described, varying in size from a pea to a hazelnut.

Right Lung.—Same as left.

Left Kidney.—The capsule stripped easily, leaving a smooth, brownish surface which showed here and there small brownish-white elevations. These extended for a short distance into the cortex and were quite well circumscribed. They averaged the size of a split pea.

Right Kidney.—On cut surface it showed a golden-yellow color. Throughout were large tumor masses which were separated by thin strands of connective tissue. No real substance could be recognized. Here and there the tumor mass had undergone softening and was infiltrated with old hemorrhages. The tumor mass was quite firmly adherent to the aorta and around this organ smaller and larger nodules of the same color and consistency as the others were seen. The entire tumor mass of both sides of the abdomen was adherent.

Case XV.—No. 6008. A. B., white male, sixty-three years of age. Died March 7, 1919.

Findings.—Right kidney. The capsule of the kidney tissue was without special features, but at one side of the section and separated from the kidney by definite bands of fibrous tissue was a tumor which is quite large.

Left Kidney.—Weighed 250 gms. It was large, lobular and adherent to the liver, the seat of an extensive tumor formation. The kidney showed several small metastatic nodules. The organ was soft. The cortex was widened and the surface was rather pale.

Liver.—The liver weighed 1350 gms. The edges were enlarged and rounded. The cut surface oozes blood and was slightly bulging, soft and pale. It presented a widespread area of metastasis in the central portion.

Left Lung.—The left lung weighed 350 gms. It was large, light, fluffy, pale and crepitated throughout. Here and there one could feel small, hard nodules. The pleura was smooth except over the upper lobe. The cut surface showed the tissue to be slightly congested and contained a small amount of frothy fluid.

Right Lung.—The right lung weighed 350 gms. It was very much like the left in that it contained a few small, hard nodules.

Left Kidney.—Weighed 250 gms. It was large, lobular and adherent to the liver. It was the seat of an extensive tumor formation. The kidney showed several small nodules. The organ was soft, cortex was widened and the surface was rather pale.

Case XVI.—No. 6132. R. L., male, white, fifty-five years of age. Died June 17, 1919.

Findings.—Right lung. The right lung weighed 700 gms. It revealed tumor nodules which were limited to the lower portion of the upper pole. On section some of these were found to be deep in the pulmonary substance, and the others to be just under the pleura. At this point the lung is adherent to the parietes.

Liver.—The liver weighed 1600 gms. The surface was smooth except where a tumor projects. On cut surface it was found to be made up of many tumors, the largest is about the size of a hickory nut. They are hard, homogeneous, yellowish-white and show evidence of necrotic change.

Left Adrenal.—The left adrenal weighed 60 gms. A hard tumor could be felt which had not broken through the capsule nor had infiltrated the kidney. On incising the adrenal only a small part of its original substance was discoverable in the form of patches applied to the periphery of the tumor. In such patches the cortex was dirty brown, underlaid by a darker reddish-brown zone. The tumor itself was gray-white, hard, and streaked with hemorrhages. There was no element of yellow and none of the necrosis grossly visible.

Right Adrenal.—The right adrenal weighed 40 gms. It maintained something of its normal form, but was distorted by the presence of 6 or 8 more or less discrete nodules. On the section surface patches of adrenal substance could be distinguished and the organ exhibited more of the adrenal substance than in the fellow. The nodules on this side were if anything harder than on the other and were gray-white, but showed no hemorrhage.

Left Kidney.—The left kidney weighed 290 gms. The capsule stripped off easily, revealing a large number of pale, yellowish-white tumor nodules. On the cut surface they were found deeper in the substance and showed the same general characteristics as those in the liver.

Right Kidney.—The right kidney weighed 280 gms. It appeared as its fellow.

Pubis.—The pubis was full on the right side. The bone was infiltrated by a homogeneous yellowish-white tissue which was evidently neoplastic.

Case XVII.—No. 7980. J. G., white male, fifty-two years of age. Died June 11, 1922.

Findings.—Right kidney. The right kidney weighed 484 gms. It was the shape of a small egg-plant with the largest portion at the lower pole. The capsule was markedly adherent to the surrounding fat which showed an inflammatory reaction. When the kidney was split open it disclosed a large white caseous-like tumor mass at the lower pole about 6 cm. in diameter. It showed a tendency to encapsulation. Toward the middle it had broken through the capsule where a large growth measuring about 4½ cm. in diameter, very cellular and vascular was growing into the pelvis and extending down the ureter. Scattered here and there in the kidney substance are other small cellular new growths that have a faint yellowish tinge. There was only a moderate amount of stroma with a marked amount of cellular tissue in this growth.

Case XVIII.—No. 9734. A. W., white male, fifty-six years of age.

Findings.—Left kidney. Weighed 350 gms.; measured 12 x 7 x 4 cm., was moderately firm. Near the upper pole there was a roundish tumor which protruded 3 cm. above the surface. Section through the mass showed it to be firmly encapsulated, and to measure 4½ cm. in diameter. The bulk of the tumor was pale yellow-brown, resembling in color and consistency normal adrenal cortex. Throughout it were seen numerous, fibrous bands and here and there smooth walled cysts which measured from a few to ½ cm. in diameter. Near the tumor, as well as elsewhere in the kidney tissue proper, there were smooth walled cysts, containing clear straw-colored fluid. The kidney as a whole was firm in consistency. The capsule was adherent to a coarsely granular, pale, gray-brown surface. The cut surface was likewise pale grayish-brown. The cortex was no longer distinguishable from the medulla. All details were washed out and the tissues appeared extremely fibrous. Peripelvic fat was moderately increased.

Case XIX.—C. E. P. Specimen removed at operation January 11, 1924.

The specimen consists of a right kidney and the upper 2 cm. of the ureter, the latter being separate. The kidney measures 13 x 6.5 x 5.25 cm. Except for the neoplastic area the surface is smooth and the capsule strips readily. Situated in the upper pole is an oval tumor 8 x 4.5 x 4.5 cm. This is evidently infiltrating in type and is covered by a thin capsule. On section this tumor is composed of homogeneous tissue. Some areas are gray and others chocolate in color and still other areas dark purplish-brown in color.

About one-third of this tumor projects beyond the outline of the normal kidney. It extends inwards to the hylus and presents the usual appearance of a malignant neoplasm. The upper portion of the ureter is macroscopically normal.

Through the kindness of Dr. Herbert Fox we were able to study the sections made from the hypernephromata that have been found in the animals at the Zoological Gardens. In general it may be said that the microscopic findings in these tumors found in animals are quite in accord with the findings in man. The following is a report of the gross findings in these tumors.

Case XX.—Coypu rat. Female, five years of age.

Findings.—Right kidney. At junction of upper and middle third and presenting under the capsule was a rounded tumor 2.7 x 2.5 cm. It was mottled purple, externally

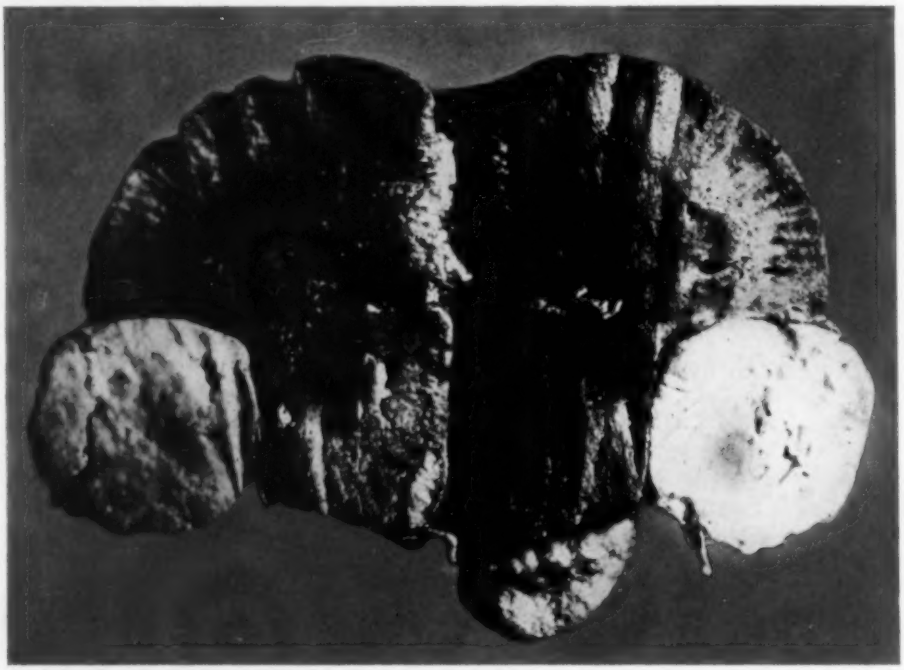

Fig. 4.—Kidney and tumor removed from Coypu rat. (Case XX, enlarged.)

dull, and on cross-section gray. The tumor was well separated from the kidney tissue and apparently growing by pushing kidney tissue away from it. It did not infiltrate.

Liver.—In general the architecture seemed to be normal but the markings were indistinct. Scattered under the capsule are pale yellow, illy-outlined, but distinct tumors. These tumors vary from 1.5 to 5 cm. in diameter.

Case XXI.—American robin. Female.

Findings.—The kidneys are deep brown dotted with pin-point yellow areas seen both on the surface and in section. In the upper right and lower left portions of the kidneys are three firm, very pale, sharply outlined, 1-mm. areas which show no surrounding inflammation.

Case XXII.——American robin.

Findings.—The tumor approximated the size of the head of the host. It extended from the region of the internal genitalia and adrenals, lying more on the right than on the left side, extending fully to the cloaca, and showed all the abdominal viscera forward. It had a pedicle springing from between the two upper lobes of the kidney where the adrenals and internal genitalia are not distinguishable. The tumor was coarsely lobulated

and nowhere adherent. It was a pale, dirty yellow color, richly marked by red lines of congested vessels. It was fairly soft, *i.e.*, about that of normal liver. Upon incising, the cut surface bulged markedly, was dirty gray-yellow blotched with dirty gray areas. It showed no internal hemorrhages or markings of special importance. No metastasis was noted.

Hypernephroma of Renal Veins.—It is not uncommon for hypernephromata of the kidney to invade the veins and even to extend into the main renal vessel. They have been reported with extensions into the vena cava as far as the heart. Hyman reports a case in which the thrombus extended into

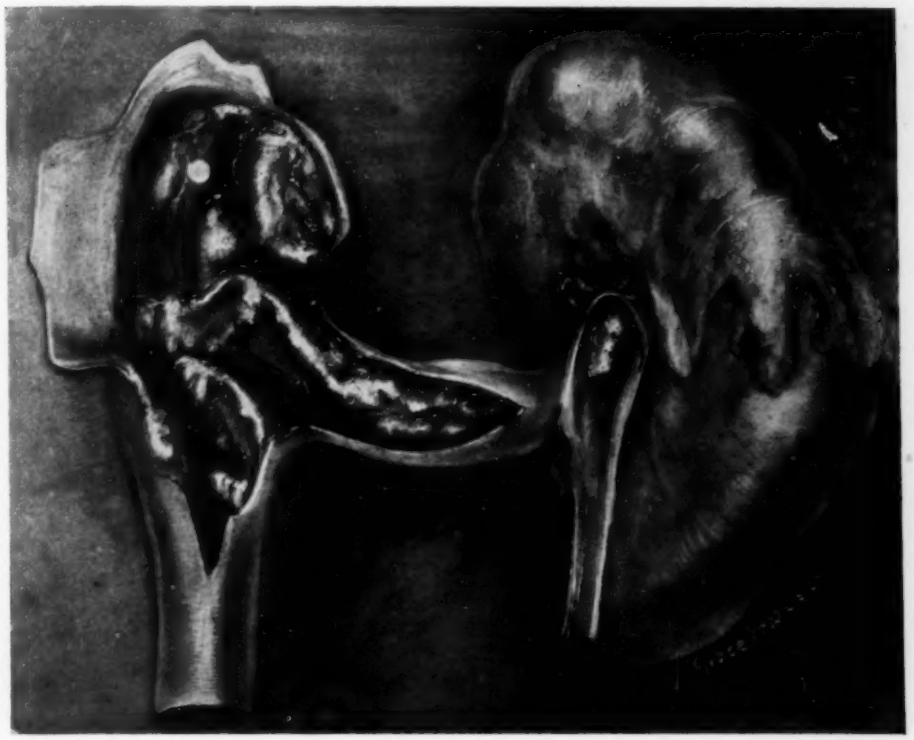

FIG. 5.—Drawing of the specimen removed from Case IV, showing the tumor extension into the renal vein, vena cava, and the ureter.

the renal vein of the opposite side. In our series, Case IV (Fig. 5), extension into the vena cava, iliac and lumbar veins was found. These thrombi may become quite long, but as a rule they give no clinical evidence of vascular occlusion which would be manifested by œdema of the extremities. While the ureters as a rule are free from invasion, Case IV showed extension of hypernephromatous tissue into the lumen of this structure. The microscopic studies of this thrombotic tissue according to Wright, show them to have hypernephromatous structures. He states further that they are separated from the walls of the blood-vessel by fibrin, white blood-cells and red blood-cells; the tumor cells growing within the lumen of the vessel, and having no connection with the vessel wall. The microscopic studies of hypernephro-

matous tissue in the renal vein in Case IV of our series, showed the lumen to be occluded by a tumor mass similar to that found in the kidney. In most places the neoplasm was merely pressed against the intima, but in several situations it was found involving the venous wall reaching into the media. In the majority of cases, however, the extension of this growth is within the lumen, without involvement of the vessel wall.

The following table shows the number of cases in our series which had renal vein involvement, and the number among cases collected from the literature:

TABLE III

Renal Vein Involvement

Name of reference	Cases	Renal vein involvement
Wright	19	4
Keyes	1	1
Bloch	86	13
Hyman	38	8
Garceau	176	4
Our series	23	2
Bierring and Albert	5	1
Total	348	33

Primary Hypernephromata.—Although the hypernephroma usually originates in the kidney, it may develop in other organs. The following table shows a series of collected cases arising primarily in organs other than the kidney:

TABLE IV

Tissue	Name of reference
Liver	Adami and McCrae; Rolleston; Schmorl; Vecchi and Noyes
Falciform ligament	Starr
Pelvis	Chiari
Uterus	Eastman
Adrenal	French; Linser; Orth; Dobbertin; Tilesius; Cooke; Beverant and Ravikild; Colcott; Fox
Tongue	Cœneus
Ovary	Gibben; Peham; Scudder; Glynn
Broad ligament	Weiss; L. Pick; Glynn
Spermatic cord	Chevassu; Debarnardi
Testis	
Retroperitoneal tissue	Glynn
Pancreas	Glynn
Ciliary body	Schlipp

The above table shows the wide distribution of primary hypernephromata. With the exception of the ones found in the tongue, and in the eye, they are in entire accord with embryological possibilities. The anlagal cells of the

TABLE V*

	Garceau	Our series	Scudder	Ershner	Bloodgood	Total
Axilla	2					2
Abdominal Wall		1				1
Adrenal—same side	1	3				4
Adrenal—opposite side	1	3				4
Bladder Wall	1					1
Brain	1		2			3
Bronchi	1					1
Clavicle	2					2
Diaphragm	1					1
Femur	7		1		1	9
Frontal Bone	2					2
Gluteal Region	1					1
General Metastasis	6					6
Humerus	2		1			3
Heart	4	1	1			6
Intestine	2	3	2			7
Ischium		1				1
Iliac Vein		1				1
Jaw	1					1
Lungs	21	8	1	1		31
Liver	8	4	1			13
Metacarpal Bones	1	1				2
Mesenteric Nodes		1				1
Mediastinal Nodes		1				1
Not stated	28					28

* This table comprises the figures of Garceau, those gathered from our own records, together with cases collected from the literature.

TABLE V.—*Continued*

	Garceau	Our series	Scudder	Ershner	Bloodgood	Total
None	83					83
Neck	2					2
Occiput	2					2
Opposite Kidney	3					3
Omentum	1		1			2
Orbit		1	1			2
Pelvic Bones	2					2
Pancreas	1	1	1			3
Pleura	5	2	1			8
Peribronchial Glands	5	1				6
Peritoneum	2	1	1			4
Regional Lymph Glands	11					11
Ribs	6			1	1	8
Retroperitoneal Tissue			2			2
Right Groin			1			1
Sternum				1	1	2
Stomach			1			1
Scapula	1					1
Scar	9					9
Skin	1					1
Spleen	3					3
Tibia	1					1
Temporal Bone	1					1
Ureter—same side	2					2
Uterus	1					1
Vena Cava	6	2				8
Vertebra—dorsal	5					5
Vertebra—lumbar	2	1				3

adrenal are so situated in their embryonic state with respect to the liver, kidney, ovary, testicle, epididymis and uterus, especially in embryos from 12 to 16 mm. in length, that one can easily see the possibility of adrenal cell inclusions in these organs. The tongue and eye, however, at no time in their embryological development are sufficiently adjacent to the adrenal ridge to make cellular inclusions possible.

When these tumors are found in organs situated so far from the usual seat of the hypernephroma as in the two cases mentioned above, it is impossible to account for their genesis. Tumors found at such distant points cannot be considered primary until a complete autopsy has eliminated the presence of hypernephromata in those organs which are the usual primary site of such growths. There are many cases on record where the first sign of tumor was referable to the secondary growth and not until an autopsy was performed was the primary growth revealed. It has been noted furthermore that the secondary growth may be very much larger than the growth whence it was derived.

Metastasis.—The hypernephromata frequently give rise to metastases. The latter may occur early or comparatively late in the course of the disease; they are often widely distributed and develop with marked rapidity. Metastatic hypernephromata are reproductions in structure of the original tumor. There may be some little alteration in the size or arrangement of the constituent cells, but in general the structure is quite like that found in the primary growth. The dissemination of the cells occurs by way of the blood stream but involvement of the regional lymphatics is not unknown; and in a few instances the lymphatic vessels alone seem to be concerned in the processes of dissemination. The bones, lungs and liver are the common sites of metastatic growths. In a certain small proportion of cases, tumors of long standing were unassociated with metastatic growths, two examples having been reported by Ohlmacher in which, notwithstanding the presence of large renal hypernephromata, no metastasis could be demonstrated. Wright refers to 13 cases out of 19 which showed no metastasis.

Metastasis may be a very early feature in the course of the disease and the local growth in the kidney may be undemonstrable notwithstanding that it has given rise to widespread metastasis, possibly with pathological fracture of an involved bone.

Kidney Location of Tumor.—The occurrence of these tumors within the kidney varies with respect to location. They have been reported as arising in all parts of the kidney. It would seem from embryological studies that the metanephros is so small in the 16-mm. embryo that cortical adrenal cells which might be included could easily be carried down to the middle or lower pole region in the development of the metanephros into adult kidney.

The following table shows the location of the tumors in our series and a few of those available in the literature:

TABLE VI

Kidney Location of Tumor

Name of reference	Region of kidney		
	Upper	Middle	Lower
Wright	6	7	5
Kuster	54	80	60
Wilson	12	14	10
Chance			1
Our series	5	1	3
	77	102	79

Total, 258 cases.

Sex.—A study of our cases and a few of the available ones in the literature showed that the males are much more prone to hypernephromata than the females. The table is as follows:

TABLE VII

Sex

Name of reference	Males	Females
Garceau	102	71
Pfahler and Ellis	71	45
Wright	10	5
Bloodgood	1	0
Wilson	15	17
Chiari	1	0
Thompson	1	0
Vicoll	1	1
Young	0	1
Goodman	0	1
Wolff	1	0
Kienan	1	0
Keyes	1	0
Hutchinson	1	1
Johnson	1	0
Strong	0	1
Frazier	1	2
Our cases	15	4
Hyman	20	8
Total	244	156

Ages.—The accompanying table shows the ages of our patients and the ages of those found in the literature.

The ages at which the hypernephromata occur has a very wide range. Most of the cases occur in individuals between the ages of forty and sixty years.

Displaced Cortical Adrenal Tissue.—Areas of displaced cortical adrenal tissue which are so commonly found in the kidney and occasionally in other tissues vary in size from pin-point to several centimetres in diameter, the

TABLE VIII

Observer	0–10	10–20	20–30	30–40	40–50	50–60	60–70	70–80
Hutchinson					2			
Keyes				1				
Kienan					1			
Wolff						1		
Goodman					1			
Young				1				
Nicoll							2	
G. B. Wilson				7	9	13	3	
Chiari					1			
Thompson			1					
Johnson					1			
Strong					1			
Frazer			1			2		
Linser	1							
Orth	1							
Dobberton	1							
Cooke	1							
Tilesius	1							
Ravikild	1							
Our series		1			4	11	3	
Garceau	4		10	17	48	61	24	3
Bloodgood			1	1	1	1	2	1
Wright			1		1	7	4	1
Hyman	1				10	11		
Max Cutler				4	8	13	7	
Stevens					1			
Briggs			1					
Total	11	1	15	31	89	120	45	5

average size being less than a centimetre. These aggregations of aberrant cells are most frequently found in the region of the superior pole of the kidney. They occupy the substance of the kidney or are found within or beneath the renal capsule. Schmorl, basing his statements upon autopsy observations, states that they may be found in 92 per cent. of kidneys.

Adrenal rests in the kidney present themselves as small, rounded, well-encapsulated, whitish bodies lying in intimate relation with, but without effect upon, adjacent kidney tissue. The size and structural arrangement of their component cells are almost identical with the cells forming the normal zona fascicularis of the adrenal gland. Among the questions arising in connection with adrenal cell rests are, should they be considered tumors, and if not, how may a large rest be differentiated from a small tumor. In attempting to apply the laws applicable to neoplasms as a class, we would be led to look upon such areas of detached tissue which remain unchanged and without evidence of vegetative activity as supernumerary bodies rather than as tumors. When an area of this kind increases in size as a result of changes in the number, size, shape and arrangement of its constituent cells with or without

invasion of the capsule, the structure loses its identity as an adrenal cell rest and becomes a tumor.

Adrenal cell rests have been found in the following organs and tissues:

TABLE IX

1.	In the male.
	In the rete testis and epididymis.
	In the paradidymis.
	On the spermatic cord, in the inguinal canal, and above and below the same.
2.	In the female.
	In the ovary, where they may easily be mistaken for shrunken corpora lutea.
	On the tubes.
3.	In both sexes.
	In the retro-peritoneal tissue below the poles of the kidneys.
	Along the internal spermatic and ovarian veins.
	On the ilio-psoas muscle at the brim of the pelvis.
	At the sacro-iliac synchondrosis.
	In the capsule of the kidney, and in the kidney substance.
	On the wall of the neighboring vessels.
	In the solar and renal sympathetic plexuses.
	Between the transverse colon and the spleen.
	In the right lobe of the liver.
	In the pancreas.
	(Tabulated by Broman).

Pathology.—The hypernephromata as a class have certain gross pathological features in common. They vary greatly in size, the smaller ones being about as large as an English walnut, the largest ones attaining the size of a fetal head. As stated above, the size of the tumor *per se* has little to do with its degree of malignancy, nor is it in any way proportional to its metastatic tendencies.

Hypernephromata may arise in any portion of the kidney, the point of origin being impossible to determine in many of the larger specimens. The degree of density of the tumor depends largely upon the presence or absence of cysts or of degenerative changes within the substance of the growth. The smaller tumors are more likely to be solid, imparting a sense of marked tension on palpation. The consistency of the larger growths is prone to be irregular, due to secondary changes already enumerated.

The section surface shows the tumor to be well circumscribed as the result of condensation of the surrounding tissues. The tumor tissue has a yellowish, fatty appearance, is prone with the release of tension to bulge somewhat, and usually shows some degree of hemorrhagic necrosis or cyst formation. Rarely is the tumor subdivided into lobules by bands of fibrous tissue. Complete encapsulation is rarely met with, but it is not uncommon to find in remnants of a capsule-like structure, evidence that complete encapsulation had existed at some stage in the development of the tumor. A portion of the growth may be covered by a thick, dense, fibrous capsule which is almost invariably and completely wanting at the point where renal invasion has occurred.

The predominating cell in hypernephromata while showing slight variation in size and shape present the greatest diversity in arrangement. Hence the classification into alveolar, cordon, tubular adenomatous and papillary types. We have noted all of these cellular arrangements in different tumors and in the same tumor. It is obvious that any classification based upon the arrangement of the cells alone must prove unsatisfactory.

We have succeeded in preparing a microscopic cross-section of an adult human kidney containing a hypernephroma which measures 8 x 4.5 x 4.5 cm. The whole specimen measures 13 x 6.5 x 5.25 cm. (Fig. 6.) The microscopic findings in this section were so instructive that we will confine our microscopic description to this tumor.

FIG. 6.—Specimen from Case XX. The large section was made from this specimen.

A study of this section shows partial encapsulation of the tumor, the side adjacent to the renal tissue being separated only by a layer of condensed kidney parenchyma. In some areas the tumor cells and kidney cells intermingle. The prevailing neoplastic cell differs somewhat in different areas in size, shape and appearance. The major interest, however, attaches to the structural arrangement of the cells which shows wide variations, so much so that alveolar, papillary, endothelial, tubular and cordon-cell groups are to be found in adjacent areas.

The capsule consists of an inner lining of dense fibrous tissue with a peripheral layer of similar tissue less dense in arrangement, in the interspaces of which are to be found remnants of renal glomeruli and suggest that the former represents a capsule inherent to the tumor while the latter has arisen as the result of condensation of adjacent kidney substance. Scattered through the outer portion are to be found small round lymphocytes indicative of chronic inflammatory reaction. The tumor cells while presenting slight variation in size are of the large polygonal type, consisting of a large nucleus surrounded by a clear vacuolized cytoplasm. The nuclei are large and stain

deeply. Mitotic figures are commonly noted. Exceptions to the foregoing are found in a few scattered cells presenting evidence of a granular cytoplasm without evidence of vacuolization. The cells nearest the centre where necrosis is evident, show the usual signs of retrogressive changes.

A small group of cells found just beneath the capsule present marked variations, they are polygonal in outline, with small nuclei showing no evidence of mitosis and surrounded by a clear vacuolated cytoplasm. These cells are divided into small groups by a fine fibrous stroma which is resting upon capillaries. These cells are in close approximation with the characteristic tumor cells giving the appearance as if the latter took origin from the small group of atypical cells. This group of atypical cells is microscopically identical with the cells normally found in the cortex of the adrenal gland in size, shape and arrangement. This, together with the fact that they show no evidence of malignancy, leads us to the conclusion that they represent adrenal rest cells. Are we justified in believing that the tumor sprang from this group of cells? (Ad. Fig. 7.)

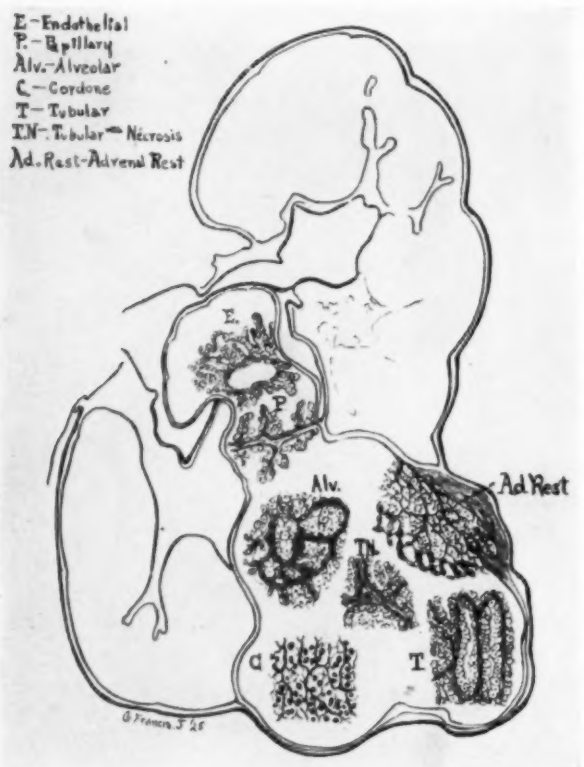

FIG. 7.—Diagram of the large microscopic section of the kidney and the tumor.

The arrangement of the stroma with respect to the cells, and the plane in which the sections are cut, gives the hypernephromata their polystructural picture. The structural forms which were seen in large section were of several types:

(1) The endothelial form was not only found in the large section, but in many of the sections made from the tumors herewith described. In the endothelial form we have a cross-section of a capillary which may be identified by blood and endothelial cells. Extending out from this vessel are several layers of the large polygonal cells arranged in a radiating fashion (E. Fig. 7.) The fibrous stroma in this form is very scant, so scant that the cells appear almost to be growing from the endothelial cells of the capillaries. There was apparently very little difference in the size of the cells which were nearest

the vessel and those which were most distant. The nuclei take the stain well.

(2) The papillary form like the others is a result of capillary development and the cellular relation. Sections cut in areas in which there is free and close branch of the capillaries always show papillary form. These areas show the cells in two or three layers resting upon the capillaries and fibrous stroma, the latter being a little more abundant in this form. There was no special difference in the general appearance of the cells from those found in other areas. (P. Fig. 7.)

(3) In some areas the capillaries are surrounded by a single layer of tumor cells. Alternate and parallel layers of cells and capillaries when seen in cross-section have a tubular arrangement. (T. Fig. 7.)

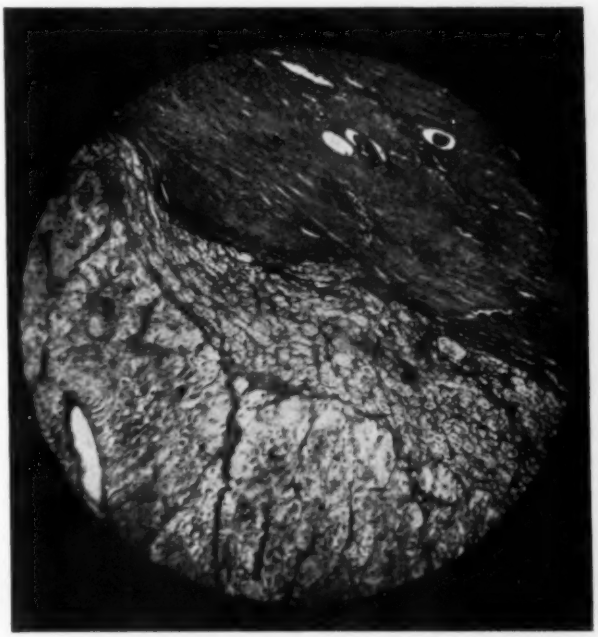

FIG. 8.—Microphotograph of area in large section which shows tumor capsul, adrenal rest and proliferating hypernephroma.

(4) The alveolar-like appearance is due to cross-sectioning of an area of tumor cells surrounded by a capillary loop. In places where the vascular loop is incomplete, the tumor cells are arranged in a semi-papillary form. (Alv. Fig. 7.)

(5) The cordon arrangement of cells found in certain areas is explained by the fact that the section has been made just above or just below the capillary vessel which latter is missing. The cells are divided into small groups by very fine fibrous stroma. This cordon arrangement suggests that arrangement found in the cortical region of the adrenal gland. (C. Fig. 7.)

(6) It is interesting to note that the cells arranged in tubular fashion seem to show the greatest degree of retrogressive change. (T. N. Fig. 7.)

We have been especially impressed in the study of this large section with the exceptional irregularity in the arrangement of the stroma, with the marked diversity in the arrangement of the cells which is due in part to the sectioning of the specimen and with the uniformity in size and shape of the constituent cells of the neoplasm.

In general it may be said that microscopically hypernephromata are tumors which are primarily made up of large polygonal vacuolated cells which are

resting upon a very irregularly arranged capillary stroma and when cut in cross-section show multi-structural formation.

CONCLUSION

1. Our embryological observations show that the anlagal cells of the suprarenal cortex are adjacent to the metanephric cells in the 16-mm. human embryo.

2. The embryological inclusion of suprarenal cells within the metanephric anlagal is not improbable.

3. Tissues other than the metanephros are susceptible to such cellular inclusions, especially those which are developed from the mesonephros, mesonephric duct and genital ridge.

4. The prominent cells of the so-called hypernephroma are similar to those found in the normal suprarenal cortex.

5. We present microscopic evidence showing adrenal rest tissue in close juxtaposition with actively proliferating hypernephromata cells.

6. The foregoing evidence indicates at least the possibility that we have demonstrated the occurrence of hypernephromatous change in an adrenal rest.

7. The hypernephroma cell and the cortical adrenal cell show great similarity in their glycogen, fat, lipoid and lecithin content.

8. Adrenal cell rests represent the cortical substance of the adrenal gland and since adrenalin is a product of the medullary cells, this substance would not be found either in adrenal cell rests or any neoplasm to which they might give rise.

9. The foregoing evidence given in connection with the microscopic studies indicates that hypernephromatous tissue may grow into the walls as well as in the lumen of the veins.

In general it may be stated that from our embryological, chemical and pathological observations the hypernephromata are quite in accord with the views originally presented by Grawitz.

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CHRONIC ULCER OF THE STOMACH: ITS EXPERIMENTAL PRODUCTION AND EFFECT ON GASTRIC SECRETION AND MOTILITY*

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Many clinicians are of the opinion that hyperacidity, hypersecretion and hypermotility, of the stomach, are common and characteristic findings in chronic peptic ulcer. On the other hand, gastro-enterologists and surgeons recognize the fact that these findings are by no means constant or pathognomonic, since not a few of the results of gastric analysis in peptic ulcer are within the normal range of physiological variation. In as much as we infrequently know the gastric acidity and motility of the patient before the actual development of the ulcer, it is an open question as to whether peptic ulcer—*per se*—induces any change in gastric physiology.

Fig. 1.—Ulcer in dog No. 12, which perforated sixty-three days after radiation.

The problem could be easily solved, experimentally, if a chronic gastric ulcer could be produced, at will, in an experimental animal. One could, then, determine the animal's secretory and motor response to a test-meal, produce the chronic gastric ulcer and observe whether or not the normal response was changed in any way.

Numerous attempts have been made in the past to produce, experimentally a chronic ulcer of the stomach. Ivy [1] has produced chronic ulcers, but it was found to be necessary to keep the animal in a poor nutritional state, which would, quite probably, *per se*, disturb gastric secretion and render the pro-

* Preliminary report for the Proceedings of the Society of Experimental Biology and Medicine, 1925, vol. xxiii, p. 45. Read before the Society of Internal Medicine of Chicago, November 23, 1925.

cedure questionable for the purpose of our problem. Dragstedt [2] has devised a method that produced chronic ulcers in sixty per cent. of the cases tried. He injected a four per cent. solution of silver nitrate under the mucosa and then, at this site, stitched in and out through mucosa, submucosa and muscularis with silk. In all cases in which a chronic ulcer ensued, suture material was found protruding from the floor of the ulcer. Because of this embedded foreign material, and the forty per cent. of failures, the method was not ideal for our work. Neither could the method of Mann and Williamson [3] be used in our study, because the procedure of production markedly disturbs the normal anatomy and physiology of the gastro-intestinal tract. Further, on the basis of Dragstedt's [2] observations, the interpretation of their results may be questioned.

FIG. 2.—Ulcer as it appeared in dog No. 3, on exploration sixty-nine days after radiation.

Method Used for the Production of Chronic Gastric Ulcer.—In 1923, at Dr. L. R. Dragstedt's suggestion, I started experiments to determine whether exposure of the mucosa of the dog's stomach to X-rays would produce an ulcer that would be slow in healing. Our opinion was, that since X-ray burns of the skin were so slow in healing, the same might be true for the gastric mucosa and present the pathological and clinical counterpart of chronic peptic ulcer in man. Ivy [4] had observed that X-ray ulcers of the stomach and intestine did not heal in the course of three months.

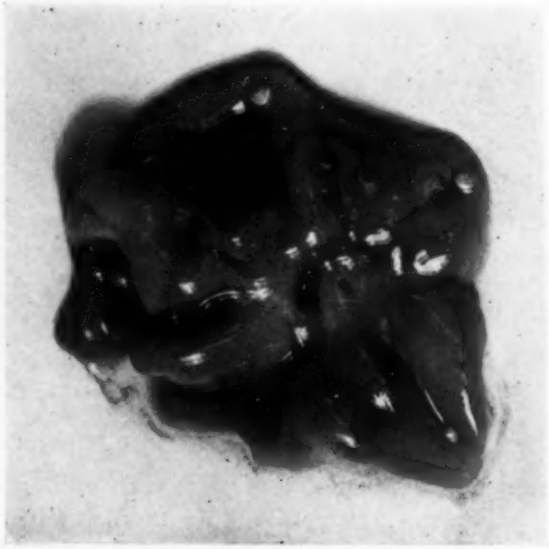

FIG. 3.—Ulcer as it appeared in dog No. 3, 585 days after radiation.

After a number of preliminary tests, it was found that an ulcer, which does not heal for prolonged periods, can be produced in the dog's stomach by the following technic: The dog's stomach is delivered through an abdominal incision. The anterior wall of the stomach is opened by a longitudinal incision just proximal to the pyloric sphincter. The posterior wall of the stomach is everted through the opening in the anterior wall, four sutures being placed in the posterior wall so that they took the position of the corners of a one inch square. The sutures were threaded through small

holes in a lead plate, which has as its centre a circular opening three centimetres in diameter, and tied so that the posterior wall of the stomach is fixed in the opening in the lead plate. Occasionally it was necessary to suture the posterior wall to the cut edge of the anterior wall to prevent leakage of the gastric contents. The area was then exposed to the X-rays. The dose of X-rays given was as follows: 110 K.V.M., 5 ma., no filter, 30 minutes. The fixation sutures were then cut and the stomach and abdomen closed. The cone and lead plate were of sufficient size to prevent the remaining gastric mucosa and abdominal viscera from being exposed to the X-rays.

FIG. 4.—Ulcer as it appeared in dog No. 7, on exploration 305 days after radiation.

Results on the Production of Chronic Gastric Ulcer by X-rays.—Every animal treated as outlined above developed a chronic ulcer of the stomach. The exact length of time required for the ulcer to appear and to heal has not been determined, which, however, is aside from the point we are directly interested in.

FIG. 5.—Ulcer as it appeared in dog No. 8, on exploration 285 days after radiation.

One animal died twelve days after the radiation, and no gross changes were manifest. Dog 12 died of a perforation of the ulcer at 63 days after radiation (Fig. 1). In dog 3 a definite ulcer was present 69 days after radiation (exploratory) (Fig. 2) and was still present at 585 days (Fig. 3). Dog 7 had a large ulcer 305 days after radiation (exploration) (Fig. 4), which, however, was found to be healed at 411

days. Dog 8 had an ulcer 1 cm. in diameter (Fig. 5) 265 days after radiation, which was healed at 384 days. Dog 16 accidentally died 104 days after radiation, and an ulcer 1 x 0.5 cm. was found (Fig. 6). This lesion appeared to be more superficial than any of the others observed at this time. In dog 18 the ulcer was resected 111 days after radiation. The ulcer was 1 cm. in diameter, the edges were indurated, the floor was dirty gray in appearance and a scar was present on the serous side with omental tags adherent (Fig. 7).

FIG. 6.—Ulcer in dog No. 16, 104 days after radiation. This ulcer was on the posterior wall about one inch from the pyloric sphincter.

The ulcers as observed by us, and as represented in the photographs to some extent at least, in the living animal have many of the characteristics of the chronic peptic ulcer in man. They are usually round or oval in shape with margins that are indurated and raised. In the early stage the floor of the ulcer is dirty gray in color, but later it appears smooth and granulating with a thickened base. With but few exceptions a scar can be found in the serosa at the site of the ulcer. Histological examination of these ulcers is being made by a competent histologist and will be reported later.

FIG. 7.—Ulcer in dog No. 18, 111 days after radiation.

Effects of the Chronic Ulcer on Gastric Secretion.—Observations were made on seven animals. The experimental procedure was as follows: (1) The normal gastric secretory response to a test-meal was determined by several tests prior to production of the ulcer. The test-meal consisted of 40 drams of corn meal in 280 c.c. of water, which was boiled for ten minutes, cooled and thinned with 100 c.c. of skimmed milk. In most cases the meal was given by stomach tube, as we found that the secretory response was the same whether the animal voluntarily ate the meal or was fed by tube. The animal was starved 18 hours prior to the test-meal. Quite often it was found that if

an animal was fed meat on the day previous to the test-meal, the acidity was higher than when meat was withheld for 36 hours or longer. (2) The ulcer was produced. (3) The response to the test-meal was followed at intervals of from 2 days to 4 weeks.

The results are shown in Table I. Dog 12 shows some increase, but it was very difficult to prevent this animal from ingesting his feces, such a procedure is known to stimulate gastric secretion.

The results show quite definitely that the chronic gastric ulcer produced by X-rays when located in the pyloric antrum from 1 to 2 inches proximal to the pyloric sphincter, does not cause hypersecretion or hyperacidity in the dog.

Effects of the Chronic Ulcer on Emptying of the Stomach.—The seven animals whose gastric secretion was studied were used for the observation of the effect of chronic ulcer on the emptying of the stomach. Control observations were made prior to the production of the ulcer. A barium meal, consisting of 60 grm. of barium sulphate and 280 c.c. of corn meal mush, was given and the time required for this to be passed from the stomach was ascertained. After the production of the ulcer observations were made at weekly or monthly intervals. We did not desire to use the fluoroscope too often, as it is known that X-rays depress gastric secretion (Ivy).

TABLE I.

Summary Chart.

No. Animal	Before ulcer production					After ulcer production				
	Average HCl			Av. content	Average emptying time	Average HCl			Av. content	Average emptying time
	Free	Comb.	Total			Free	Comb.	Total		
11c	9.6	25.3	34.9	315 c.c.	3 hrs., 5 min.	4.9	26.5	31.5	252 c.c.	2 hrs., 41 min.
12	2.16	14.0	16.16	237 c.c.	2 hrs., 22 min.	13.2	23.0	36.2	.....	2 hrs., 26 min.
13	3.2	21.9	25.1	209 c.c.	2 hrs., 45 min.	1.1	18.2	19.3	175 c.c.	2 hrs., 36 min.
14	6.7	24.6	31.3	168 c.c.	2 hrs., 40 min.	10.8	25.1	35.9	209 c.c.	2 hrs., 37 min.
15	2.1	13.9	16.0	198 c.c.	2 hrs., 5 min.	0	17.0	17.0	165 c.c.	2 hrs., 32 min.
16	0	19.0	19.0	269 c.c.	2 hrs., 31 min.	0	21.0	21.0	223 c.c.	4 hrs., 15 min.
17	0.7	28.8	29.5	217 c.c.	2 hrs., 29 min.	2.3	31.8	34.1	218 c.c.	3 hrs., 55 min.

The results (Table I) show that the normal dog's stomach emptied the meal in from 2½ to 3 hours when animal is starved for at least 18 hours. In dogs 16 and 17 ulcer was located near pyloric sphincter, nearer than in the other animals in whom it was located 2 inches proximal to the pyloric sphincter. In these two dogs there was a definite delay in emptying of stomach. These results show that if ulcer is located 2 inches proximal to pyloric sphincter, it has no effect on emptying of stomach; but if it is located near the pyloric sphincter, the emptying of the stomach is delayed.

Discussion.—Our observations unquestionably show that a chronic ulcer of the stomach can be produced by a proper dose of X-rays, and that this ulcer

anatomically resembles chronic "peptic" ulcer in man. Anatomically this ulcer should cause any perverted physiology that a "peptic" ulcer would cause in man. Physiologically there may be a difference in that "X-ray ulcer" may not involve the local reflex mechanisms in the same way that, they are involved in "peptic" ulcer. This possibility is, however, entirely hypothetical.

The fact that no significant change in gastric secretion was caused by the ulcer even when located near the pyloric sphincter supports the frequently observed clinical fact that in chronic ulcer of the stomach in man, even when located near the pylorus, the acidity of the gastric contents is frequently within the normal limits of variation. It may be, however, that if the ulcer were located at the pyloric sphincter, that some change in gastric secretion might occur. But we are certain from our experimental results that when the ulcer is located from 1 to 2 inches from the pyloric sphincter that gastric secretion is not significantly altered.

The results on emptying time are especially interesting and significant, in that they show that if the ulcer is located near the pyloric sphincter that gastric retention occurs; but if it is located two inches from the sphincter no retention occurs. In other words, the ulcer has only a very local and quite narrowly circumscribed effect on the intrinsic nervous mechanisms. In man, however, in whom psychic factors undoubtedly play a greater rôle than in the dog, long reflexes may be excited by the pain, distress, etc., which may lead to change in gastric motility and secretion that would not occur in the dog.

This question of the effect of chronic "peptic" ulcer on gastric secretion and motility can only be unequivocally answered when the gastric secretion and motility of patients have been determined prior to the development of an ulcer. With attention directed to this matter it is to be hoped that physicians will look for such cases and report them.

SUMMARY

1. A chronic ulcer of the stomach that grossly resembles "peptic" ulcer can be produced by a proper dose of X-rays.

2. Such an experimentally produced chronic ulcer located from one to two inches proximal to the pyloric sphincter does not cause any change in the gastric secretion of dogs.

3. When the ulcer is located near the pyloric sphincter (one inch), a delay in emptying of the stomach occurs; but no delay occurs when it is located two inches from the sphincter.

4. The hope is expressed that physicians will look for cases of gastric ulcer in which studies of gastric secretion and motility have been made, for some reason, prior to the development of the ulcer.

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CHOLECYST-DUODENOSTOMY*

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Beginning with Winiwarter (1882), various attempts to drain the gall-bladder into the intestine were made, and in 1902, Radsiewsky was able to collect 56 cases of anastomosis of the gall-bladder to some portion of the gastro-intestinal tract. In 1909, Mayo-Robson, and in 1913, Kehr, reported that they had each done some 60 operations of this type, the former using the intestine and Kehr the stomach. All surgeons of experience have performed a number of these operations. The indications for "internal drainage" of the gall-bladder have been variously listed, and among the most recent are those formulated by Deaver: (1) Calculus cholecystitis occurring in those past middle life, complicated by chronic pancreatic lymphangitis, chronic pancreatitis and early biliary cirrhosis. (2) Irremovable obstruction of the lower end of the common duct, most commonly due to carcinoma of the head of the pancreas. (3) Large diverticulum of the common duct. (4) Irreparable injuries of the common duct distal to the cystic duct.

Cholecyst-gastrostomy may be considered as advisable in certain cases of gastric ulcer and internal drainage might be of use in chronic or intermittent jaundice of obscure origin, but I cannot agree with those, DuBose, for instance, who advises internal drainage as a palliative operation in poor risk common duct obstructions or perforation of the gall-bladder. Internal drainage must not take the place of external drainage. A chronic obstruction in the head of the pancreas is the indication of choice and further, there must be but little disease of the gall-bladder and no trouble with the cystic duct. I am not discussing in this paper the sequence of cholecystectomy and choledochoduodenostomy.

A few months ago I had occasion to operate upon three patients suffering from chronic jaundice. The following are brief abstracts of the case records:

Case I.—No. 1388. M. McC., aged sixty. Indigestion for several months and moderate pain in the upper right quadrant of the abdomen. Four months later vomiting and jaundice developed. Two weeks ago had "chills and sweats." Has lost ten pounds in weight. The jaundice has shown variations. Admitted to Misericordia Hospital, September 17, 1925. Was quite jaundiced. Van den Bergh test showed an indirect reading of 20 units. Coagulation time was 4½ minutes. *Operation.* September 21, 1925. Gall-bladder greatly dilated. No stones could be felt in gall-bladder or ducts. Pancreas apparently contained a hard nodular growth and the peripancreatic lymph-nodes were enlarged and hard. The diagnosis of *carcinoma* of the pancreas was made and a cholecystoduodenostomy performed by the method to be described. Wound drained with one rubber tube. The patient made a fairly rapid recovery and was discharged, October

* Read before the Philadelphia Academy of Surgery, March 1, 1926. From the Surgical Division of the University of Pennsylvania.

11, 1925. She was seen on March 1 by her physician, Dr. Clement Bowen, who reports that she is quite well and free from jaundice. X-ray examination shows the tube still *in situ*. The van den Bergh test showed a bile serum content of 0.7 units.

CASE II.—No. 7135. C. C., aged sixty-three. Onset was rather sudden and dates to the middle of September, 1925, when an attack of sharp epigastric pain was experienced, preceded by about twenty-four hours during which time he "felt weak and shaky." Pain was severe, continued for an hour or so and was relieved by morphine. He went back to work the following day. One week later jaundice was noted and has continued, but there has been no recurrence of pain. Admitted to *University Hospital*, November 25, 1925. Coagulation time 4½ minutes. Van den Bergh 22.5 units (indirect). *Operation* November 28, 1925. The gall-bladder was found to be extremely distended and did not contain stones. No stone could be palpated in the cystic or common ducts. I did not believe it was advisable to open the duodenum and search for a lesion of the ampulla of Vater. The man was quite ill and the pancreas was moderately enlarged and might have been the cause. It was, therefore, decided to do a cholecystoduodenostomy. One rubber tube for drainage. Patient made an excellent recovery. Van den Bergh on December 3, 1925 was 9.8 units. Van den Bergh on December 9, 1925 was 3.4 units. Discharged December 16, 1925. Patient was examined on March 1, 1926, and is quite well. X-ray shows the tube still in place. The van den Bergh test showed 0.5 units.

FIG. 1.—Posterior row of linen suture. Mushroom catheter tied in gall-bladder by purse string. Purse string ready in duodenum.

CASE III.—No, 7333. M. G., aged sixty. Has had attacks of epigastric pain for fifteen years. No jaundice. Present attack began three weeks ago as "sour stomach," though he had no pain, no chills, no vomiting. Two weeks later jaundice noted and this has been progressive. Admitted to *University Hospital*, December 7, 1925. Coagulation time, 4 minutes. Van den Bergh 3.5 units (indirect). *Operation* December 8, 1925. The gall-bladder was found to be distended with dark bile. Palpation of the head of the pancreas revealed an extensive carcinoma which was apparently obstructing the common duct. There was extensive metastasis to the retroperitoneal lymph glands. No stones could be detected in gall-bladder or ducts. A cholecystoduodenostomy was performed. The abdomen was closed without drainage. Patient made an excellent recovery. December 12, 1925 van den Bergh 12.5 units. Icterus index 98 units. December 18, 1925 van den Bergh 3 units, Icterus index 70 units. December 23, 1925 patient discharged. Patient examined on March 4, 1926 and is quite well. X-ray shows tube still in place and van den Bergh test showed 1.0 units. He has gained forty pounds in weight.

In the first case of this series I was confronted with the necessity of relieving a rather deep jaundice in a patient who apparently had a carcinoma of the

pancreas. I did not have small clamps and could not use the regular ones available. I was averse to the use of the Murphy button, although I note that Ashhurst advises its use "if it is impossible to apply rubber-covered clamps to prevent fecal extravasation during the operation." While simple suture methods have been made easier by the use of modern aspirating devices I still felt rather uneasy about leak and decided to use a rubber tube. Such tube has been used many times to effect the juncture between the hepatic or the common ducts and the stomach and also the intestine. At first the tube was withdrawn after a time, but Sullivan in 1909 showed that this was unnecessary because the tube would be pulled down into the duodenum by peristalsis and so passed from the rectum. Even if it does not pass, Brandt (1921) thinks that no harm will result. I had forgotten the recent paper by DuBose (*vide supra*) and fortunately so because the method here described is simpler than his. The gall-bladder was aspirated of its bile and then sutured to the duodenum for nearly one inch by a continuous linen suture, rather closely applied and by means of a small needle. The ends were left long. A mushroom catheter, size 20 F, and cut to four inches in length, was carefully pushed into the opening made by the aspiration in the gall-bladder and fastened in place by a circular purse-string suture of No. 0, iodine catgut. The other end was inserted through a one-quarter inch opening in the duodenum, and this opening inverted by a similar catgut suture. The linen Lambert suture was continued anteriorly. No omentum was used to wrap the joint, no leaks occurred, and in the third cases we were sufficiently emboldened to close the wound without drainage.

FIG. 2.—Catheter put into duodenum. After purse string is tied an anterior row of linen suture works the two openings together.

This method apparently has a great advantage besides simplicity of technic. Deaver believes that in the absence of complete obstruction of the common duct these openings close sooner or later. Presumably, this is due to contracture at the suture line and hence we believe the mushroom catheter will remain *in situ* much longer than the simple tube held in place by a stitch as in the DuBose method or, when it is finally passed, the opening will be quite

large. C. H. Mayo has recognized this point in describing his operation. "An opening one-half inch in diameter is made in the fundus of the gall-bladder, the peritoneum is denuded for about one-quarter of an inch from the opening; it is then passed for one-quarter of an inch, through an incision at a conveniently near point, into the lumen of the duodenum. Such openings prove more permanent than the margin-to-margin union of the opening in the gall-bladder to the opening in the duodenum."

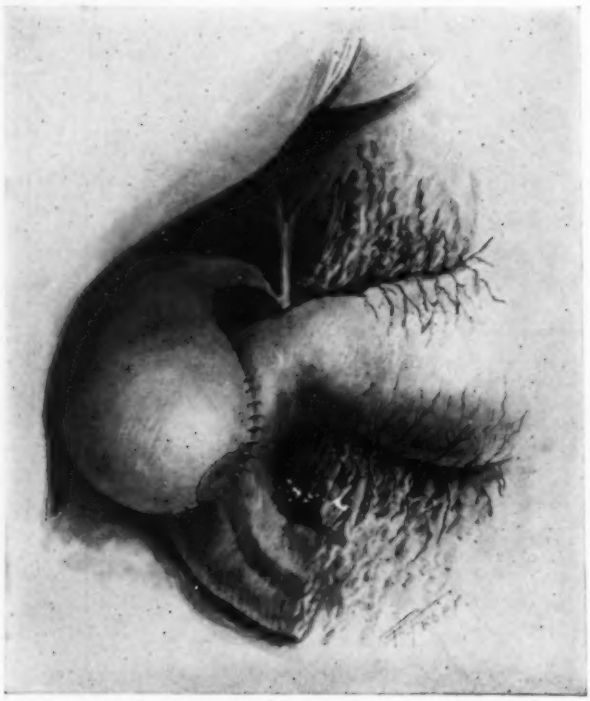

FIG. 3.—Suture completed. Tube in position draining the gall-bladder.

In my patients the redevelopment of jaundice should indicate closure of the fistula if the common duct is not patulous. If these patients are suffering from chronic pancreatitis and not carcinoma and they remain well it is immaterial whether or not the fistula closes. The fact might be ascertained by the Graham test.

It does not seem worth while spending time discussing the sites of the anastomosis. All recent writings indicate that either the stomach or duodenum must be chosen. Moynihan does not "choose any other part than the stomach or duodenum." Deaver thinks that it is a Hobson's choice between these, but the latter is more physiological. Judd seems to prefer the stomach. It is interesting, however, to note what is contained in certain popular text-books. Binney mentions an antero-colic and a retro-colic method for performing cholecystenterostomy. He considers the latter superior and quotes the operation of Brentano (1907), whereby the jejunum is pulled up to the gall-bladder through a rent made in the transverse meso-colon. DaCosta says: "I believe Brentano is right, and that it is best to do posterior cholecystenterostomy, bringing the jejunum through an opening made in the transverse meso-colon."

Something has been made of the probability of infection after anastomosis with different parts of the bowel and hence the recent experimental work of Gatewood and Poppens is of interest. They performed experiments on dogs in which the gall-bladder was anastomosed to the stomach, duodenum, and colon. They conclude: "(1) The gall-bladder invariably becomes infected

regardless of the viscus used for anastomosis. (2) There is little, if any, difference between the stomach and duodenum in the matter of rapidity of infection. (3) The colon is not the portion of the gastro-intestinal tract to be chosen by preference. The immediate dangers of peritonitis are much greater, and probably liver infections would occur earlier than when the upper part of the gut is used. (4) All livers become infected sooner or later if the method employed in the experiments be followed. (5) Cholecystenterostomy, from an experimental standpoint, is not an operation to be recommended for use except in well-selected cases, such as carcinoma of the pancreas where the temporary comfort of the patient is paramount, or in irreparable common duct obstruction."

In a paper advocating cholecystenterostomy, Heyd says that "the adequate sterilizing mechanism of the stomach prevents ascending infection." But there are some reliable investigations by Gilbert and Dominici showing that the bacteriological count in the stomach is higher than in the duodenum, and Gatewood and Poppens found, "in every instance, whether the animal lived 1 or 300 days, and regardless of the viscus employed for the anastomosis, the gall-bladder was infected."

As this paper is only concerned with the details of the technic of cholecyst-duodenostomy I have not entered at all into any other details. It is interesting to speculate as to whether or not these patients are suffering from chronic pancreatitis or from carcinoma, and it seems to me that time alone will decide the matter.

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ACUTE PRIMARY INTUSSUSCEPTION IN THE ADULT *

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Acute intussusception in the adult is very much less common than in infants and children. Cases in which the condition occurs without any other abdominal lesions, such as appendicitis, ulcers of the ileum or tumors of the intestine, are rare.

In their monograph on intussusception, Perrin and Lindsay [1] reported that only eighteen of their four hundred patients, or 4.5 per cent., were over the age of fourteen. As a matter of fact, 314 of their patients, or 78.5 per cent., were under the age of two. A survey of the literature bears out this general average. At least 95 per cent. of all reported cases of acute intussusception apparently have occurred in children.

The usual underlying cause of intussusception is a foreign body, or its equivalent, in the intestines. The common development of invagination of the bowel in children is probably dependent on the fact that, in early life, the mucosal folds of the gut are excessively developed and studded with lymphoid follicles. Taken in conjunction with the fact that the juvenile colon has a relatively narrow lumen, a swelling of the lymph follicles, such as may occur in a variety of intestinal disturbances, may furnish the anatomic conditions suitable for the occurrence of an intussusception. The actual telescoping of the bowels usually results from the provocation of some gastrointestinal disturbance of a coliky nature.

Lutzow-Holm [2] has commented on the fact that in Norway intussusception is uncommon, only twenty-nine cases in that country having been published up to 1923. In England and Denmark, on the contrary, invagination of the gut is exceedingly common. Lutzow-Holm calls attention to the extensive use of castor oil and calomel for children in the latter countries as a possible explanation for the greater frequency of intussusception.

After the age of seven, the development of the mucosal folds and the lymphoid follicles begins to regress. At the same time, the colon progressively enlarges so that it is increased threefold in diameter by the age of fifteen. It is probably largely for these reasons that primary intussusception is so uncommon in the adult.

When intussusception does occur in the adult, it is usually secondary to some demonstrable defect within the abdomen, such as tumors of the intestine, acute appendicitis or ulcers of the ileum. The case that I am reporting was unusual in that, notwithstanding a careful examination of the abdominal contents, none of these abnormalities could be found.

* I am indebted to Dr. Carl G. Burdick, Director of the Fourth Surgical Division, Bellevue Hospital for the privilege of reporting this case.

Two cases similar to mine in this respect were reported by Moore [3] in 1924. They were observed during the Mohammedan fasting season, at which time the Mohammedans abstain completely from food and drink from the early hours of the morning until sunset. Both patients had previously been in perfect health. They were seized with the symptoms of intussusception at the close of the days' fast. One was suddenly stricken after drinking a glass of cold water; the other, before taking any food or drink. Both died. In neither case did the post-mortem examination of the intussusception and the rest of the intestines show anything in the nature of a tumor of the intestinal wall or a swelling of Peyer's patches to account for the invagination.

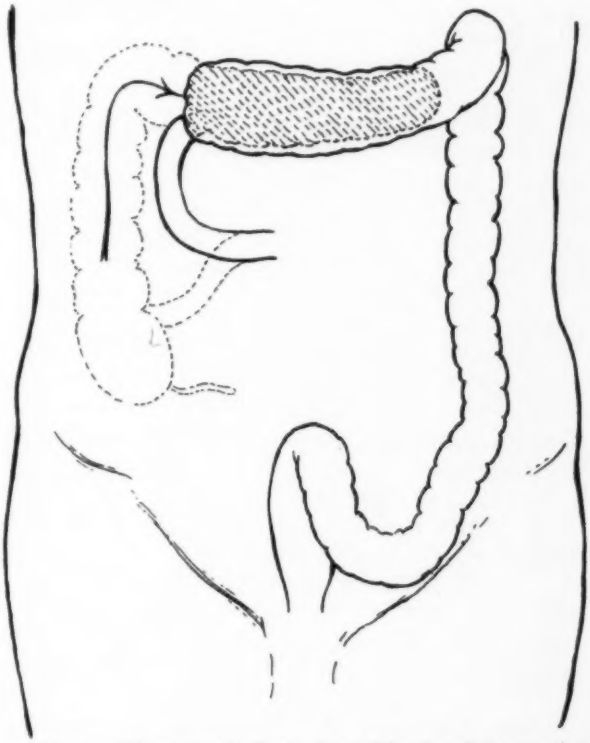

FIG. 1.—Diagrammatic sketch of condition found at operation. The cæcum, vermiform appendix and a portion of the ileum had invaginated the ascending and transverse colon, almost as far as the splenic flexure. No other abdominal lesions were found.

Probably the most important factor in influencing the prognosis of acute intussusception is the promptness with which laparotomy is performed. When the abdomen is opened within twenty-four hours and the intussusception reduced by hand, as in the present case, the outlook is excellent. But when there is delay and intestinal resection is required, the situation becomes grave. To experiment with intestinal irrigations and manipulation by rectum is to fritter away valuable time while the patient's condition rapidly becomes critical.

I believe that the appendix should be removed in all cases of intussusception in the ileocæcal region, as this structure may well serve as a starting point for a recurrence of the disturbance.

In the case here reported, the cæcum and part of the ileum invaginated by the ascending colon without any apparent cause other than a dietetic indiscretion. At operation, no other abnormality of the abdominal contents could be found. The intussusception was reduced by manipulation, and the patient made an uneventful recovery.

E. R., aged thirty-two, an Italian restaurant worker, entered Bellevue Hospital, September 18, 1925, complaining of severe abdominal pain.

The family history was negative. The patient smoked about twenty cigarettes a day and was in the habit of sleeping sixteen hours. Herniotomy had been performed in 1909. He had a chancre in 1918, for which he had been treated with ten injections of neosalvarsan and thirty-three of mercury. He had also had malaria and two gonorrhœal infections.

The patient gave a history of several attacks of epigastric pain, which lasted for a few days but disappeared without treatment; he had also had several spells of dizziness without syncope. In 1918, while in Bombay, India, the patient had an attack similar to the present complaint.

The present illness began on the evening of September 17, 1925, when, after eating some cake, the patient promptly experienced a severe stabbing pain in the epigastric region. Later, the pain shifted to the right lower abdominal quadrant. He had a chill and vomited three times. He remained in bed for twenty-four hours; but, since there was no relief, he was then admitted to the hospital.

Physical Examination.—The appearance of the patient was that of a young man, weighing 139 pounds, apparently suffering from severe pain. The temperature was 99° F.; pulse, 64. The tongue was heavily coated, and the teeth were in poor condition, showing several neglected cavities. There was a soft systolic murmur at the apex of the heart.

The abdomen was slightly rigid, the muscle spasm being confined to the upper and lower quadrants on the right side. Over McBurney's point, tenderness was pronounced; there was also tenderness in the whole right flank and at the right costovertebral angle.

The clinical impression was that the cause of the disturbance was acute appendicitis. Immediate operation was advised.

Operation.—A right rectus incision was made, the fascia and muscle were split, and the peritoneum was opened. There was difficulty in finding the cæcum, which was abnormally placed, but it was finally picked up.

Near the gall-bladder, a mass that proved to be a six-inch invagination of the cæcum was found. The vermiform appendix and a portion of the ileum were also invaginated into the ascending colon. The condition found is diagrammatically illustrated in the accompanying illustration (Fig. 1.) With the exception of being a little darker than normal, the gut was of normal appearance.

The intussusception was reduced by manipulation.

The cæcum looked somewhat œdematous; the appendix appeared normal. A careful search of the abdominal contents was made for the purpose of discovering a tumor or other lesion to account for the development of the invagination. None was found. The appendix was then removed in the usual manner and the abdominal wall was closed. Recovery was uneventful, and the patient was discharged from the hospital September 30.

Pathologic Examination of Appendix.—The appendix was 6 cm. long, gray and smooth. There was a little resistance to cutting, indicating some degree of thickening of the wall. The lumen was filled with pale, gray, necrotic débris.

Microscopic examination showed lymphoid hyperplasia with sclerosis.

CONCLUSIONS

1. A case of acute intussusception in a man, aged thirty-two, is reported. Early operation was performed and the patient made an uneventful recovery. Careful examination of the abdominal contents failed to reveal any other abnormality.

2. The prognosis in intussusception depends (a) upon the time elapsing before operation, and (b) upon the condition of the intussusceptum with reference to the need for resection.

3. The routine removal of the appendix is a valuable measure, in association with the reduction of the intussusception.

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THE SURGICAL TREATMENT OF ACUTE APPENDICITIS*

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Broadly considered, a discussion of all the various phases of acute appendicitis might be included in a paper entitled the "Surgical Treatment of Acute Appendicitis." The relationship of precision in diagnosis to the reduction of both morbidity and mortality by eliminating the rapidly increasing penalties of delay and its contribution to successful treatment by sifting out the cases of acute appendicitis from the familiar group of cases of indefinite character, would be properly included. The influence of the duration of the period of anæsthesia upon the development of respiratory complications would merit consideration, as well as the numerous advantages of an anæsthesia skilfully conducted. In a more limited sense, judgment would be passed upon the proper size and situation of the incision and upon the methods best suited to the prompt accomplishment of the purposes of the operation with the least possible liability necessarily assumed as a result of the injury to the abdominal wall, the excision of the appendix, and the existence of contamination or infection of the peritoneal cavity.

A series of 259 consecutive personal cases of acute appendicitis, operated upon during the past seven years, affords the data for such figures and comments as are embodied in this discussion. There were 166 males and 93 females. Among the 259 cases there were 10 deaths, a mortality of approximately 3.9 per cent.

One hundred and eighty-two cases were operated upon as emergencies, that is, they were either added to the list of regular morning operations, but not originally on that list, or were operated upon outside of regular operating hours, the operating-room being set up for them.

One hundred and thirty cases had intra-abdominal drainage, twenty-one being drained to the peritoneum. Of the specimens arriving at the pathological laboratory, 39 were reported as gangrenous appendicitis, 103 as acute or sub-acute suppurative appendicitis, 42 as acute or acute catarrhal appendicitis, and 25 specimens were divided between œdema of the appendix, lymphoid hyperplasia, mucocele, or chronic appendicitis. Six appendices were reported as normal. For the most part the operative findings and the laboratory reports were in accord, but occasionally in somewhat violent disagreement.

In reviewing the operative procedures as applied in this group of cases and the course of events following operation it is felt that the McBurney, or intermuscular incision, has contributed a not unimportant part. This incision as applied, along with certain methods that, through constant usage, have gradually established themselves as a routine, might warrant brief description.

* Read before the New York Surgical Society, April 14, 1926.

A three and a half-inch incision is made at right angles to an imaginary line passing between the umbilicus and the anterior superior spine of the ileum. The centre of the incision crosses this line at a point three-quarters of the distance from the umbilicus to the anterior spine. The incision is thus somewhat higher up and further out than is perhaps usual. The peritoneal cavity is entered, ordinarily, directly over the cæcum or toward its outer surface in the region of the lower right gutter. It is quite usual to see nothing of the small intestine throughout the course of the operation, except when elevating the cæcum a small portion of the terminal ileum in the region of the ileo-cæcal valve may be brought into view. A finger is introduced into the abdomen and the appendix felt for and delivered if possible. If not, the base of the cæcum is brought through the wound and while held between the fingers of the left hand, the proximal part of the appendix is sought for with the fore-finger of the right. The appendix is then delivered through the wound, if free, or if adherent it is liberated by enucleation with the right fore-finger. The base of the appendix once identified, adhesions that may be present are separated by working the finger closely along the surface of the appendix in whatever direction this may take, carefully avoiding so far as possible separation of adhesions present between other structures adjacent. In this way an appendix abscess is often broken into at the point that the appendix in its course enters into it.

It is obvious that by this method, the operation is performed by the sense of feel rather than by the sense of sight. Exudate or blood, or both, are removed by means of suction. An abdominal pad of any sort has very rarely been employed, and then only for the control of the bowel.

The stump of the appendix has most commonly been treated by inversion. Ligation of the stump with depression beneath a purse-string suture has been frequently employed, but for the most part discarded. The danger of intra-intestinal hemorrhage does not seem to be sufficiently great to justify the creation of an infected pocket in the wall of the cæcum. Where drainage was to be established and time conserved in the sicker cases, simple ligation of the stump was deemed entirely adequate (57 cases). In several cases where a necrotic appendix disintegrated during the process of liberation from adhesions the stump was never seen, and no attention paid to it (4 cases). In cases of œdema or of inflammatory changes in the cæcal wall about the base of the appendix, any suture involving the wall of the cæcum was thought undesirable.

Drains were placed, as far as possible, so as to avoid their crossing over the anterior surfaces of cæcum or small intestine. The wound was always closed with particular care, pains being taken to obtain close coaptation of the peritoneal wound, avoiding gaps between the stitches, splits in the peritoneum and particularly to exclude deeper structures from the grasp of needle or suture. Where a drain was employed, the wound was closed up to the drain on either side.

The rubber-dam drain, composed of folded dental rubber, and varying in size according to the needs of the individual case, has been employed in all of

the 151 cases drained. It has proven highly satisfactory, is well tolerated by the tissues and without the tendency to do harm by pressure common to drains of more rigid materials. A separate small incision for drainage either in the flank or above the symphysis has occasionally been made, but rarely. When cases have been committed to drainage the drain has not been withdrawn for from seven to ten days. During the first few days the drain was loosened in the abdominal wall, then gradually shortened until removed, as conditions indicated.

No particular routine or scheme of treatment has been adhered to in the post-operative care of these patients. If there has been a policy of any sort it has consisted in the endeavor to do as little as possible to the patient in the way of treatment. The Gatch-bed was utilized to obtain the degree of Fowler position desired when necessary. Morphine was employed with restraint. Enemata were administered as early and as frequently as needed. The flax-seed poultice to the abdomen gave comfort in the presence of gas pains, and, with the rectal-tube, assisted materially in the reduction of distention. Fluids by mouth, preferably hot, were limited at first. Lavage was occasionally resorted to when necessary to empty a distended stomach or one over-loaded with accumulated fluids. Saline under the skin afforded additional fluid to dehydrated or toxic cases. Frequent dressings facilitated drainage in freely suppurating wounds. The usual cardiac stimulants were resorted to in the desperate cases.

The complications represented among these two hundred and fifty-nine patients fall naturally into the two general groups of those possessed prior to the attack of acute appendicitis and those that developed during the convalescence. In the former group valvular cardiac disease, pulmonary tuberculosis, acute and chronic nephritis, pernicious anæmia, diabetes, rheumatism and pregnancy were all noted, and had their influence upon the course of the disease.

The post-operative complications of outstanding importance were consequent to the inflamed appendix and the operative wound. Twelve patients ran sustained temperatures or developed secondary temperature curves, due presumably to imperfect drainage or secondary accumulations, but all recovered without operative interference. Seven patients developed secondary abscesses requiring incision and drainage, one of these being drained through the rectum and one through the vagina. There was one sub-diaphragmatic abscess.

Four wounds closed at operation were drained because of infection. Three wounds broke down to the extent of requiring secondary suture. There were two persistent sinuses, following primary drainage, both patently tuberculous. Three patients bled into the bowel, all to an alarming degree, but all recovered spontaneously. As in all three cases the stump of the appendix had been merely ligated and the wound drained, the explanation of this bleeding was difficult.

Four patients developed a rather violent diarrhœa. One patient was operated upon on the ninth day for an acute intestinal obstruction. Respiratory

complications were represented by three cases of bronchitis, one of pleurisy and one of pneumonia. Of the one hundred and thirty cases that had intraperitoneal drainage through the McBurney incision, eighty-three have been subsequently seen and examined. Seven were found to have developed an incisional hernia, while six more had a possible weakness of the scar but have not as yet presented a definite hernia. The occurrence of hernia through a McBurney incision with deep drainage would thus be approximately 8.5 per cent.

Occasion for both comment and explanation is afforded by the fact that among two hundred and fifty-nine cases of acute appendicitis there was no fecal fistula, nor was an ileostomy performed. Several of the drained cases were suspected of having, or of being about to have, a fecal fistula. The possible existence of this condition was suggested by the apparent contamination of the purulent discharge from the wound with intestinal contents, as indicated by discoloration or at times by the escape of small quantities of gas. This was too transient in all cases to be convincing or to permit of a definite diagnosis of fecal fistula. In no case was formed fecal matter of sufficient size to permit identification present in the discharge, or was there passage of any considerable amount of gas, or leakage through the wound during the administration of an enema. While the occurrence of a fæcal fistula may at times, be inevitable, particular precautions were observed against the development of this unfortunate complication. Undue trauma was carefully avoided at all times in carrying out the successive steps of the operation. In abscesses of long duration, or in those presenting dense, unyielding adhesions, or when, after reasonable endeavor, the whereabouts of the appendix could not be determined, the abscess was merely drained, and the appendix not removed. In cases of œdema or marked inflammation of the cæcal wall all suturing of this structure was omitted. When simple ligation of the appendix was employed, the level of ligation varied with the calibre of the appendix, but in all cases was at least one-quarter of an inch from the cæcal wall. The soft, rubber-dam drain prevented possible pressure sloughs of the wall of the bowel, large or small. The identification of the cut edges of the peritoneal incision and their suture by sight prevented the inclusion of intestinal wall in the suture line, so readily possible in the presence of distention, or when the bowel tends to boil out of the wound or of attempted closure without proper exposure of the parts under repair.

Ileostomy was not utilized for the reason that convincing indication for its employment did not present itself, supplemented perhaps, by a lack of conviction as to its efficacy. It is not a remedy for true observation, as by postoperative adhesions. It not a cure for peritonitis. The disadvantages of the procedure, both immediate and remote, are obvious. It has failed to save many patients; others might have recovered without it. Cases of acute appendicitis presenting abdominal distention before operation quite commonly show a marked increase in this distention after operation, a change for the worse that can be fairly attributed to the operation itself. A short operation,

the inter-muscular incision, the avoidance of unnecessary trauma, the exclusion of pads from the abdominal cavity, and a favorably situated rubber-dam drain will all help greatly in limiting to the least possible such aggravation of distention as the operation itself is responsible for, and, in this way, narrow down considerably the indication for ileostomy.

In reviewing the ten fatalities it is doubtful that in any case ileostomy could have reversed the outcome. Four patients died of general peritonitis, with intense intoxication, two on the day of operation and two on the first day following, the oldest of these being five and a half years of age. One patient was far advanced in diabetes at the time of operation, and one—a young adult—presented equally advanced acute nephritis. One patient did very well so far as the abdomen was concerned, death being attributed to chronic disease of both heart and kidneys, with terminal pneumonia. Another, operated upon under local anæsthesia for an abscess of long duration, succumbed to œdema of the lungs due to an old myocarditis and circulatory failure. Two of the ten cases terminating fatally came to autopsy. In one a general peritonitis was found, with multiple localized abscesses, and dilated jejunum and stomach. There was gangrene of the omentum and an extension of the gangrenous process originating in the appendix to the cæcum and ascending colon. It was in this case that ileostomy was most seriously considered. The other patient examined post-mortem was moribund at the time of operation. The operation was performed under local anæsthesia, and what was thought to be a localized abscess, drained. A general peritonitis was found, with congestion of the lungs.

A discussion of the operative treatment of acute appendicitis would be incomplete without an expression of opinion, if merely personal, upon the relative merits of the McBurney and the vertical type of incision, made either through the rectus sheath or through the semi-lunar line. In 259 operations the McBurney incision has been made 238 times, the right rectus 15, the remainder unrecorded. The incision through the semi-lunar line has not been utilized at all. Its disadvantages are well known, but it was avoided chiefly because of its inherent weakness and mistrust of its ability to withstand the stress of the post-operative period. Its usefulness is limited.

The advantages of the McBurney incision are numerous. It offers the most direct approach to the appendix in the great majority of cases. When placed well up and out the peritoneum is opened over the cæcum, often in the region of the right gutter. The abdomen entered in this point the cæcum, lower ascending colon and terminal ileum serve as abdominal pads, walling off the rest of the peritoneal cavity. The operation can usually be carried out in the right gutter, the retrocæcal space, and to the right of and behind the terminal ileum, approaching the true pelvis by this route, permitting practically an extra-peritoneal operation in many instances. There is the least possible breaking up of essential limiting adhesions, as between bowel and anterior abdominal wall, or of bowel to bowel, or of omentum to either or both. Drains may be advantageously placed either in the right gutter, the retro-cæcal area,

or the true pelvis without producing undesirable pressure upon large or small bowel. It is a strong incision, reducing to a minimum anxiety as to the welfare of the wound always inseparable from such post-operative contingencies as excessive abdominal distention, vomiting, coughing and prolonged suppuration. It rarely breaks down in its entirety. It is followed by but few incisional hernias. Unless placed too low, it cannot justly be held as a contributing cause in the development of right inguinal hernia. Finally, the same operation can usually be performed through a smaller McBurney than right rectus incision.

The McBurney incision is enthusiastically advocated in all cases of early acute appendicitis, and in the majority of late cases, the disease being localized in the right iliac fossa or right gutter. The chief objection to the McBurney incision is the ever present possibility of error in diagnosis. In certain cases of appendicitis of long duration it is less satisfactory than the right rectus incision.

It may be said in favor of the right rectus incision that it permits of better exposure and a more favorable opportunity for exploration. It cannot be advocated as an incision less likely to break open in whole or in part during the post-operative period, or less likely to be followed by incisional hernia. Adopted as a routine, the removal of the appendix through this incision will involve a relatively longer incision, since the approach to the base of the cæcum is less direct; a more extensive breaking up of limiting adhesions, the frequent need, perhaps routine use of the abdominal pad, and the employment of a drain so situated as to cross over the anterior surface of one or more portions of bowel, particularly in cases of abscess in the right gutter. In cases of prolonged suppuration secondary hemorrhage from the deep epigastric artery, a known cause of two deaths, is a very real menace, while the formation of adhesions, residual to an unfavorably situated drainage sinus, may, at a later time, be the source of abdominal pain or some degree of obstruction. The right rectus incision is better adapted to an operation performed by the sense of sight, the McBurney incision to an operation performed largely by the sense of feel. In acute surgical conditions of the lower abdomen of doubtful diagnosis the right rectus incision has abundant use and indication. In cases of acute appendicitis of several days' duration, with absence of mass or acute local tenderness in the right lower quadrant, and evidences of a pelvic abscess of appendiceal origin below, the right rectus incision is by all means the incision indicated. In such cases the cæcum is probably low, the appendix situated in the pelvis, and under such circumstances the removal of the appendix, the ligation of the stump and the drainage of the abscess can be most readily accomplished through the right rectus incision.

The great majority of acute abdominal conditions in children requiring surgical interference will prove to be acute appendicitis. In most of these the McBurney incision should be the incision of choice. Ovarian cyst with twisted pedicle and intussusception call for the vertical incision, as do the cases of

pelvic appendix with abscess formation already mentioned. Cases of streptococcus and pneumococcus peritonitis would be preferably explored through a vertical incision. All these conditions give diagnostic indications of their own, almost invariably too clear to permit of a definite diagnosis of acute appendicitis. Assuming that it is possible to exclude intussusception and ovarian cyst as a source of error in diagnosis and that in cases of streptococcus and pneumococcus peritonitis the type of incision resorted to is immaterial, the percentage of error in cases operated upon as acute appendicitis in children through a McBurney incision will be far too small to carry weight as an argument for the adoption of the right rectus incision as a routine. It will generally be found that the percentage of occurrence of incisional hernia following the right rectus incision is greater than the percentage of occurrence of conditions not readily dealt with through a McBurney incision made under a mistaken diagnosis of acute appendicitis.

In adults the chance of error in diagnosis is greater. In pelvic abscess of appendiceal origin, or in acute surgical conditions of the lower abdomen of doubtful nature the lower right rectus incision is advocated. In a situation of uncertainty of diagnosis as between acute appendicitis and acute conditions of the gall-bladder, stomach, duodenum or pancreas, and where the probabilities favor acute appendicitis, the exploratory McBurney incision is recommended. If the appendix is found to be involved a second and separate incision through the upper right rectus is made. This has seemed preferable to an initial noncommittal type of incision, unsuitable for any operation at first, and then unduly lengthened either upwards or downwards to meet particular indications.

Notes were made recording the approximate position of the appendix as determined at operation in 169 cases. In 116 the appendix was found to be sub-cæcal or retrocæcal; in 24 it lay in the right gutter, and in 29 it was in the true pelvis. It will be seen that according to these observations the appendix occupied the right gutter nearly as frequently as the true pelvis, while in 140 cases it was readily available through the McBurney incision. The majority of the cases presenting an appendix situated in the pelvis were operated upon early, so that in the absence of an old abscess or extensive adhesions the appendix was readily fished out through a McBurney incision.

In conclusion, the methods advocated in the surgical treatment of acute appendicitis, derived from a study of the cases reported herewith, may be summarized as follows:

1. The removal of the diseased appendix by an operation performed with the least possible operative trauma, particularly to other intra-abdominal structures.

2. The McBurney incision in the great majority of cases, as affording the most direct and least objectionable approach to the appendix, and permitting most satisfactory drainage when necessary.

3. The lower right rectus incision in the cases of longer duration, particularly indicated in the presence of pelvic abscess of appendiceal origin, and in cases in which the diagnosis is quite doubtful.

4. The use of suction during the course of the operation to remove exudate.

5. The use of the folded rubber-dam drain.

6. The employment of simple methods in dealing with the appendix stump in very sick patients.

7. The drainage of abscesses in very sick patients or in the presence of complications, under local anæsthesia.

8. Simplicity and conservatism of post-operative routine, so far as possible, made possible in many instances, by an operation that includes as much as should be done, and omits all that should not be done for the welfare of the patient.

DISLOCATION OF THE CARPAL SEMILUNAR BONE

By Charles E. Farr, M.D.
of New York, N. Y.

Injuries about the wrist-joint have received much more attention in the recent literature than formerly was the case. Fractures of the radius, or of the radius and ulna, are, of course, by far the most common. Other conditions, such as fractures of the scaphoid and dislocation of the semilunar are being noted more frequently. Any of these lesions may occur alone or in various combinations. Concomitant injuries of the soft tissues overlying the joint or adjacent to it also form a serious factor in proper treatment and in the end results.

Fig. 1.—Bilateral dislocation of carpal semilunar, right wrist.

Dislocation of the semilunar rarely, if ever, occurs without more or less severe trauma to the other bones entering into the wrist-joint. Indeed, it would seem impossible to apply sufficient force to luxate this centrally placed bone without serious damage to the ligamentous and bony structures which give the wrist its strength and its flexibility.

During the last seven years, about twenty cases of dislocation of the carpal semilunar have come under my observation, twelve of which have submitted to closed reduction or excision of the bone. No open reduction has been accomplished. Only one was seen on the day of accident. This was reduced with great ease and gave an excellent result. Others varied from a few days to a few weeks in duration. Closed reduction was effected in seven, excision done in three, partial reduction accomplished in one, treatment only for late stiffness of joint in one.

The end results in early reduction are excellent. Late reduction or excision may give fairly good but not perfect function. About 10 per cent.

permanent stiffness and weakness of the wrist will usually occur in late cases. However, Dr. Reginald Sayer stated in discussing one of these cases (personal communication) that he had succeeded in a closed reduction in one case after three months with excellent results.

Etiology.—The usual history of a fall on the outstretched palm such as is seen in Colles' fracture, holds for these luxations. All have been in male adults running from twenty to forty-five years of age. No special etiologic factor was found. It is probable that a very marked hyper-extension of the wrist occurs and that the bone is forced from its bed while the wrist-joint is thus wide open.

FIG. 2.—Bilateral dislocation of carpal semilunar, left wrist.

Diagnosis.—Without the use of radiograms only a good guess may be made, but the presence of a painful, weak, swollen wrist with a special swelling on the anterior surface and rather marked limitation in flexion with local tenderness are quite suggestive of the lesion. The proper diagnosis has been made in this series on several occasions before confirmation by the X-ray.

Treatment.—Immediate reduction is the invariable rule unless other conditions forbid the necessary manipulations. Deep ether anæsthesia is advisable although early cases may be successfully reduced under nitrous oxide. Forced extension to the very limit of the wrist's possibilities is carried out by an assistant. The operator then catches the semilunar in its exposed position with his thumbs, using the tips only, tilts it over the brim into the radial cup and holds it there. The assistant then slowly flexes the hand, if necessary using traction to open the wrist further. Direct pressure by the operator's thumbs slides the semilunar into its bed. In early, easy cases with only moderate swelling and no adhesions or complications, the bone will be felt to snap into its bed just as in reducing an elbow or shoulder. In older cases, much force will be required. Reduction may not be perfect. The soft parts are much traumatized and considerable local post-operative reaction will occur.

Damage to the median and ulnar nerves and blood supply of the dislocated bone would seem inevitable. A careful dissection of the wrist-joint in a cadaver at the Cornell University Medical School proved this danger an ever present one.

The after treatment is much like that for Colles' fracture. Immobilization in molded plaster splints for about two weeks, baking from the beginning, gentle massage, active and passive motions after ten days, taking great care to cause no pain. On the removal of splints a snug, elastic supporting bandage is a comfort and tends to prevent late œdema.

The end results will depend as in other fractures and dislocations, on the age and general condition of the patient, especially as regards arthritic taint, and on lesions of the soft tissues, especially the nerves. Early reduction and proper care in young adults will give practically perfect results. Late reduction or excision in those past thirty-five will usually result in a slight degree of loss of complete extension and in some weakness of the wrist with synovial grating in the severe cases. One case, in a man past forty years of age, too long immobilized and with evident nerve pressure, complicated by an old luetic infection, had slight persistent stiffness of the fingers two years after discontinuing treatment.

Case I.—A young man fell from a ladder over twenty feet, sustaining a fracture of the patella and spraining both wrists severely. The patella was sutured. An X-ray of the wrists showed a dislocation of the semilunar in each (Figs. 1 and 2), the only bilateral dislocation noted so far in the cases reported. Because of the serious conditions present and the delay in making the diagnosis, reduction was delayed and complete success was obtained on one side only. On the opposite side, reduction was nearly complete, the posterior edge of the semilunar catching on the os magnum but not entering completely into its proper articulation. The result was excellent on the reduced side and quite good, but not perfect, on the other side. This case was in the Harlem Hospital in the service of Doctor Luckett.

Case II.—A man, thirty years of age, caught by an automobile and thrown against the side of his garage. He sustained a comminuted fracture of the left clavicle and a dislocation of the right semilunar with fractures of the radius, ulna and scaphoid. Because of his serious injuries, X-ray examination and reduction were delayed a week. Nevertheless reduction was only moderately difficult. At the end of seven weeks there was nearly perfect return of function. The report at the end of several years was perfect. He is able to do hard labor all day long without symptoms, and has full range of motion.

Case III.—A man, thirty years of age, had his right hand jammed between two cases. The wrist became swollen and painful at once. A dressing and splint was applied. An X-ray was taken and a dislocation was noted between the os magnum and semilunar. In this case the os magnum was dislocated from the semilunar and the latter retained practically its normal relationship with the other bones of the carpus and the radius. He was referred to the hospital ten days after the injury. Examination showed his right wrist much swollen with a noticeable posterior bulge over the wrist-joint. All motions were painful and limited. Under full anæsthesia with nitrous oxide ether, and twenty minutes manipulation, reduction was at last accomplished. The procedure was hyperflexion and extension carried out to the full range of motion with great force. Then with the wrist in hyper-extension the os magnum was pushed forward with all available strength. At the second attempt a soft grating was heard and felt, and reduction was found complete under the fluoroscope. This was confirmed later by X-ray.

It seems reasonable to believe that most dislocations of the semilunar really start in this way as dislocations of the os magnum backward. As the force is continued the os magnum drives the semilunar from its pocket in the carpus, and itself resumes a more normal position in the wrist. This is noted repeatedly on partially successful reductions of the dislocated semilunar. The bone reaches nearly a normal postion in the carpus except for its relations with the os magnum. This particular case was therefore diagnosed as a dislocation of the os magnum rather than of the semilunar, but is included under the general heading of dislocations of the small bones of the carpus.

Several cases were seen so late that reduction could not be accomplished, even when considerable violence was expended. The bone was removed by a short anterior incision. Even when exposed during the operation, it was moved from its firmly fixed position with some difficulty. It would hardly seem possible to effect a closed reduction in such cases. Open reduction did not appeal at the time.

The after treatment in these operative cases consists of a short period of immobilization, followed by baking, massage, and early active and passive motion. The end results in all was good but not perfect. A residuum of weakness and laxness of the wrist was present, amounting to about 10 per cent. Motions in all were normal.

CONCLUSIONS

Dislocation of the carpal semilunar is fairly common and is frequently overlooked. The diagnosis with fluoroscope or X-ray is easy. Reduction in early cases is not difficult and gives excellent results. Late reduction is difficult and sometimes impossible. The results are fair. Operative removal is necessary in irreducible cases although open reduction has at times been accomplished. Excising results fairly well, with only a moderate degree of weakness.

The end result of unreduced dislocation is a considerable stiffness of the wrist with weakness and pain over a long period. A certain amount of this disability can be overcome in young subjects, but a return to anything like normal use could hardly be expected.

Monnard [1] has had twenty cases of dislocation of the semilunar treated by various methods. He states that immediate reduction under anæsthetic is the ideal method. There is a return of 90 per cent. of motion and 85 per cent. of power within nine weeks. Cases treated by operation with reduction give the poorest end results as regards function and power. Late cases treated by conservative means or by excision of the bone gave fair results. He advised conservatism in the late cases. This gives a range of motion of 70 per cent. and of power of about 75 per cent. after eleven weeks treatment. With excision motion was limited to 56 per cent. and power to 57 per cent., with a seventeen week period of disability.

REFERENCE

[1] M. Monnard, Lausanne. Revue Medicale de la Suisse Romande. Oct. 25, 1925.

TRANSACTIONS

OF THE

PHILADELPHIA ACADEMY OF SURGERY

Stated Meeting Held March 1, 1926

The President, Dr. Charles G. Mitchell, in the Chair

CHOLECYST-DUODENOSTOMY

Doctor George P. Muller read a paper with the above title, for which see page 95.

In connection with the paper he presented a patient who had been subjected to operation May 20, 1924, for a growth involving the ampulla of Vater, which the biopsy demonstrated to be a carcinoma. It was destroyed with the actual cautery. The patient when presented appeared to be perfectly well.

HYPERNEPHROMATA

Doctor Albert E. Bothe read a paper with the above title, for which see page 57.

SUBDIAPHRAGMATIC AND LIVER ABSCESS FOLLOWING APPENDICITIS

Doctor E. L. Eliason read a paper with the above title, and illustrated it by lantern slides.

In illustration of his subject, Doctor Eliason presented a man, aged twenty-four years, who was admitted to the University Hospital, on the night of November 4, 1925, with a history that three days before admission he was taken with generalized abdominal pain. For two days he remained in bed with some abdominal pain and slight nausea. On the afternoon of the third day, the pain seemed to grow more severe and became localized in his right lower abdomen.

On admission the patient appeared acutely ill. Temperature, 101.4°; pulse, 100; respirations, 20. Examination showed a scaphoid abdomen, with marked tenderness and rigidity over the whole lower right abdomen. There was a suggestion of a mass about 4 cm. mesial to the right anterior spine. Peristalsis was active except in the lower right abdomen. White blood cells, 18,200.

He was operated upon shortly after his admission. A McBurney incision was made under local anæsthesia. The peritoneum was found thick and œdematous and adherent to the wall of an abscess cavity from which cloudy fluid escaped when opened. The opening was immediately over the appendix which was found gangrenous throughout almost its entire length and lying free in the abdomen, except for a slight attachment of its distal part to a bit of œdematous meso. The appendix was removed. The appendix had already become detached from the cæcum at its base; no other effort was made at ligation or inversion of the stump. A split rubber tube was inserted into the pelvis and three cigarette drains were placed around the caput cæcum.

The day following operation he seemed to be doing very well. Peristalsis was present and drainage was profuse. His abdomen gradually became quite

distended and peristalsis was much reduced. Hot flaxseed poultices were placed over his abdomen and finally one ampule of pituitrin was given. These measures relieved his distention almost at once.

On the eighth day after his operation the patient complained of a pain in his right chest on coughing or deep breathing. He had developed a slight cough two days previously. Examination revealed dullness at the right base and axilla with diminished breath sounds and few râles. The heart seemed pushed to the right side. The X-ray confirmed the clinical diagnosis of massive atalectasis—right base, or bronchopneumonia. The heart was in the normal position at the time the X-ray was made. The operative wound continued to drain profusely and the discharge was dark in color with a fecal odor, and at his dressings gas escaped from his wound.

The patient's general condition improved gradually and his chest cleared, but his temperature continued to be of the hectic type, rising to 101°–102° at night, suggesting pylephlebitis with liver abscess.

Leucocytes, 17,800. A Van den Bergh test showed no increase in bile pigments in the serum. His chest signs were clearing and he had no tenderness, œdema or dilated veins over his liver. His blood culture showed no growth.

A week later his chest signs seemed to change, with increased dulness at the right base. An X-ray showed fluid, which was aspirated, 120 c.c. of clear yellow fluid was obtained.

The day following this aspiration he showed for the first time tenderness over the liver area. A fluoroscopic examination demonstrated a high fixation of the right diaphragm.

December 2, twenty-eight days after his first operation, an exploring needle found pus just above the ninth rib in the anterior axillary line. Under local anæsthesia then a portion of the ninth rib was removed subperiosteally. In doing so the pleura was torn slightly, allowing some serous fluid to escape into the wound. No attempt was made to open the abscess, but the parietal and diaphragmatic pleuræ were sewed together around the needle to close the pleural tear.

Two days later the pus cavity was again located and opened with a cautery. The blunt aspirator inserted into the cavity evacuated about six ounces of thick foul pus. The tract was enlarged sufficiently to admit a large rubber drainage tube and packing.

Three days after his liver abscess drainage, the patient developed colicky abdominal pains, with increased peristalsis and hiccough. He was slightly distended. The next day he vomited. The temperature was normal. A diagnosis of partial intestinal obstruction was made and an enterostomy performed under local anæsthesia. A left gridiron incision was made and a catheter inserted into a distended loop of ileum. He drained freely through the tube.

From that time on he gradually improved. The fecal fistula drained less and less, and his bowels moved regularly. The enterostomy tube was removed fourteen days after its insertion, and the liver abscess drainage grew less.

He was discharged December 24, 1925. Since his discharge he has gained about 25 pounds in weight and his fecal fistula has remained closed since February 9.

Doctor John P. Jopson asked Doctor Eliason to what extent he relied on the aspirating needle for his diagnosis before operating. It had been his fortune to see a fairly large number of cases of subphrenic abscess, complicating intra-abdominal infections, and in only one was there evidence of liver infection, with free discharge of bile from the drainage tract, and this patient

died. The proportion of cases of liver abscess in Doctor Eliason's series is in striking contrast to the general experience.

DOCTOR ELIASON, in replying, said that in every one of his cases the needle was inserted into the abscess and with it still held in position, the rib was resected and then an opening made in the diaphragm and thence into the liver. In three of the cases there was a subdiaphragmatic abscess, but all these were connected with a liver abscess.

DOCTOR ASHHURST had said when one of these cases was reported before the Academy, that the foreign literature showed many cases of single abscess of the liver reported as following acute appendicitis. While the reporter hesitated to make the statement, the actual facts were that only three of the cases showed diaphragmatic abscess and they without exception had an opening into the abscess in the liver; hence it was taken for granted that they were primarily liver and secondarily subdiaphragmatic. All were diagnosed with the needle and many were from one-half to two and one-half inches deep in the viscus.

DOCTOR ELIASON also presented a man, sixty-six years of age, who was admitted to the University Hospital, November 1, 1925, after having had acute upper right abdominal pain and vomiting for forty-eight hours. He had had several such attacks during the three years previous to his admission with considerable indigestion and transient attacks of distention associated with palpitation. He lost about sixty pounds of weight during the year previous to his admission.

On admission the patient appeared acutely ill with considerable loose cough and in evident pain. Temperature 102, pulse 120, respirations 28. His examination showed an emphysematous chest with many râles throughout both lungs, but no areas of consolidation. He had a systolic murmur at the apex. His abdomen was rigid and acutely tender over the upper right quadrant and a mass could be felt below the chondral attachment of the ninth rib. Leucocytes 21,700.

He was operated on under local anæsthesia. A right rectus incision was made disclosing a mass composed of omentum adherent to a large, tense gall-bladder. The adhesions were separated from the tip and the gall-bladder was aspirated. About 2 ounces of white, purulent material were removed. The scoop inserted into the gall-bladder brought away several stones and considerable muddy, brownish material. Inflammatory œdema of the omentum and gastro-hepatic structures made exploration difficult, but no further stones were palpated in the gall-bladder or cystic duct. The head of the pancreas was enlarged and firm. A cholecystostomy was performed and drainage tubes placed about the gall-bladder.

The patient did fairly well after operation and drained bile on the third day. His tube was removed on the tenth day after operation and his wound gradually healed until he was discharged, twenty-seven days after his admission. The chronic bronchial cough persisted throughout his stay in the hospital.

The patient was admitted again December 16, 1925, after three days of acute upper right abdominal pain with vomiting, anorexia, and fever. He was found to have marked upper right abdominal tenderness and rigidity. His previous wound was healed. Temperature 101.5, pulse 110, respirations 22. A diagnosis of pericystic abscess was made and he was treated conserva-

tively for five days with hot flaxseed poultices in the hope that he would drain through his previous sinus tract.

December 21, under local anæsthesia, a transverse incision was made and the abdomen cautiously opened at the outer edge of the rectus. The opening was directly into a large abscess cavity which was aspirated of about 1500 c.c. of foul, purulent fluid. A rubber tube drain was inserted into the cavity. His pain was relieved immediately and he did well except for his persistent cough.

Five days after his operation the patient again seemed weak and listless, his temperature was of the hectic type between 100.3 and 98, his leucocytes were 20,600. His blood serum showed no increase in biliary pigment. He had no jaundice clinically. Examination of his chest showed marked râles over both bases. The right base showed percussion impairment, no diaphragmatic movement could be demonstrated on the right side. A subdiaphragmatic or intrahepatic abscess was suggested as the diagnosis. An X-ray of his chest made the day following showed a large subdiaphragmatic collection on the right side with fluid level and an adherent diaphragm. There was some lung reaction above the diaphragm.

Two days later, under local anæsthesia, a portion of the tenth rib was removed in the right anterior axillary line. An aspirating needle previously inserted above this rib obtained pus. The sharp-pointed aspirating trocar was inserted and about 1000 c.c. of thick, purulent material were evacuated. Incidental to the rib removal the pleura at the upper limit of the wound was inadvertently ruptured. This wound was immediately closed by sutures to the diaphragmatic pleura. An exploring finger inserted into the abscess cavity could palpate no area in which the process seemed to extend into the liver. Drainage tubes were inserted upward over the dome of the liver and downward toward the subhepatic abscess cavity.

Drainage was copious from these wounds, but six days later he again began to show temperature elevation to 102 and an attempt was made to obtain fluid by aspiration of the chest because there were signs of a fluid collection. No fluid was obtained. An X-ray taken four days later, however, showed a fluid level in a cavity in the right lower chest. The exact location could not be determined whether pleural or within the lung.

The following day, on aspiration above the eighth rib in the anterior axillary line, the cavity was located and considerable pus was obtained after resection of the rib. There seemed to be no connection between this cavity and the subdiaphragmatic collection which could be demonstrated.

Since this operation the patient has gradually improved. His thoracotomy wound rapidly closed, although a small collection was found above the anterior end of this sectioned eighth rib which was subsequently drained.

His abdominal wounds were dressed by irrigations and on February 3, 1926, the irrigation from the subhepatic drainage tube was found to appear at his subdiaphragmatic drainage wound. These sinuses were enlarged to admit the insertion of larger drainage tubes.

Since that time the patient has gradually improved, gaining strength and weight. His temperature has been normal since February 15, 1926, except for an occasional rise to 99. The drainage from his wounds is slight and is gradually decreasing.

Doctor H. K. Pancoast remarked that a röntgenologic examination can materially assist in reaching a diagnosis of liver abscess or subdiaphragmatic abscess provided it is carried out in the proper manner, and with the true clinical picture of the case in mind. We have failed in the röntgenologic

diagnosis in several instances because of a lack of knowledge of the case, which was responsible for either a misinterpretation of findings or the carrying out of an incomplete or improper technic. In practically all of the cases in which surgeons have failed, some useful knowledge would have been gained by the proper conception of the pathological condition and a correct clinical understanding of the cases.

Many of the cases have presented a lung reaction of some kind in the röntgenogram. In some instances there has been a supposed lobar pneumonia and in a few, a sterile pleural effusion. Many of the cases came for their Röntgen-ray study with the clinical picture of an intrathoracic condition such as a pneumonia and not with the one referring to the abdominal condition. They were misled, therefore, in interpreting their findings from the standpoint of a chest condition. For example, with a clinical history of a very recent pneumonia, one would be led to believe that the high, fixed or restricted diaphragm due to the hepatic or subphrenic abscess was a sequelæ of pneumonia.

In order to carry out the examination properly, it is absolutely essential that every case have a fluoroscopic examination in addition to the radiographic part of the procedure. Röntgenograms alone will not show what is wanted to be known.

The röntgenologic characteristics of the condition are essentially: (1) More or less elevation of the diaphragm, depending upon whether a hepatic abscess is near the upper surface of the liver or the abscess has ruptured under the diaphragm. (2) Restriction of the diaphragm if hepatic or fixation if subphrenic abscess is present. (3) The absence of any condition above the diaphragm to account for these phenomena, except the usual lung reaction where suppuration is near the diaphragm. Only the proper conception of the true clinical picture will prevent misinterpretation of this lung reaction.

DRAINAGE OF THE URINARY BLADDER

Doctor Alexander Randall discussed the problem of drainage following suprapubic cystotomy, and the methods they were now using to keep the patient dry. At the time of operation, instead of using the Freyer drain, they are using a tube with multiple perforations at the distal end, which has been moulded to a short and gentle curve by boiling while stretched over a special frame. It allows of the tube being turned immediately at the level of the skin coming out under the dressings without kinking. On removal of the tube, on the third or fourth day, the patient is then dressed by a large rubber (or oiled silk) sheet, one yard square, with a hole in its centre one inch in diameter, which is placed over the wound with the hole centred on the fistula and the sheet secured to the skin by a special cement consisting of gum mastic thirty parts, Canada balsam five parts and ether thirty parts. This cement dries rapidly, sealing the dam to the skin. Dressings are then put over the fistula and the rubber sheet folded up at the sides

and ends, being held by Montgomery straps. Later when the patient is ambulatory, they are using a special cup, of German silver, developed by Doctor Muschat, of the Urological Staff, which is held over the fistula by perineal and belt straps, being sealed to the skin by boric ointment. Its principle is that the cup has a broad flange three to five cm. in width which distributes pressure and allows of water-tight sealing. This cup drains from the bottom and keeps the patient dry and at the same time allows of a complete estimate of urine output. A fourth apparatus used in severe toxic cases where complete aspiration of purulent bladder contents is desired, consists of an electric-driven pump working on a vacuum bottle. This machine, perfected by Doctor Moorhead, is driven by a silent electric motor at slow speed and suction is controlled by mercury pressure which can be gauged to any amount desired. These methods have been developed and proven in clinical use to be devoid of any deleterious effect for the primary healing of the wound where sutured, and have aided materially in the comfort of the patient, promptness of his convalescence and a saving in hospital supplies.

SAMPSON'S CYST OF THE OVARY

Doctor Floyd E. Keene presented a specimen typical of endometrioma of the right ovary with minute implants on the opposite ovary. The condition is by no means rare, being found in from 20 to 30 per cent. of abdominal operations on women. According to Sampson's conception, which has been almost universally accepted, cells from the endometrium or tube are carried out through the Fallopian tube finding lodgement on the surface of the ovary, which acts as an incubator for their growth into cyst formation. Minute transplants may be found on the ovary, as well as in the cul-de-sac on the surface of the sigmoid, posterior surface of the uterus, the appendix, etc. These cysts rarely, if ever, reach large size. They are always adherent and contain a chocolate-colored fluid which is old blood. While histologically the lesion is not malignant, according to Sampson's conception the endometrial cells follow out closely the dissemination of carcinoma in that he has demonstrated them in blood- and lymph-vessels, in inguinal glands, and the common tendency is to show penetration and perforation into surrounding organs, particularly the sigmoid, bladder and rectovaginal septum. The wall of the cyst is lifted by a membrane analogous to endometrium, although occasionally, particularly in very old cysts, this typical membrane may be partially or totally lacking.

Symptoms: Often there are no symptoms whatever referable to this condition. It is rarely seen in women under thirty years of age nor after the menopause. Dysmenorrhœa is commonly present, often premenstrual in type. Should there be invasion of the sigmoid or bladder, symptoms referable to this invasion are usually exaggerated at the time of menstruation, being quiescent often during the interval. Sterility is commonly present and irregular menstruation, particularly menorrhagia, may be noted.

Treatment: Because of the dense adhesions often associated with these cysts, radical removal is often necessary, although in young women resection of the cyst may be the advisable procedure. When symptoms arise due to invasion of neighboring organs, as for example bladder and rectum, resection of both ovaries should be done. Following upon this there will be a rather rapid diminution in the size of the secondarily affected organs with complete subsidence of symptoms, showing that excision of the transplants from the rectum or from the bladder is unnecessary.

TOXIC GOITRE

Doctors Charles H. Frazier and W. Blair Mosser read a paper entitled "Control and Treatment of the Toxic Goitre," for which see page 51.

Doctor Edward Rose remarked that the records of 201 admissions of patients with thyroid disease in Doctor Frazier's service from the latter part of September, 1922, to the middle of December, 1925, showed eighteen cases in which there was sufficient evidence of cardiac disease to warrant special medical observation and treatment. All were subjected to operative procedure—fifteen survived and three died. Of the three deaths, two were attributable to cardiac disease—the other was not. The majority of these cases were in the fifth decade; all had high basal metabolic rates; all exhibited tachycardia; all but one had lost a great deal of weight; and the majority had had arrhythmias at one time or another. Six had established auricular fibrillation, and three (all of the fatal cases) had paroxysmal fibrillation. The result of this study was to indicate, first, that digitalis is often not effective in controlling the heart rate or reëstablishing compensation; and second (which was rather surprising), that many patients with hyperthyroidism have a high degree of tolerance for digitalis. One patient received sixty-nine grains of powdered digitalis in eighteen days without any evidence of digitalis intoxication, but with marked improvement of his circulatory condition. Digitalis apparently has no effect in controlling the tendency to paroxysmal fibrillation, although it will often reduce the rate during a period of fibrillation. The judicious administration of iodine as Lugol's solution often has beneficial effects on the circulation indirectly in hyperthyroidism by reducing the basal metabolic rate, thus possibly allowing the digitalis to take hold, so to speak, more effectively. They were impressed by the good results which can often be obtained by careful pre-operative and post-operative observation and treatment of cardio-vascular conditions in cases of toxic goitre which at first seem almost hopeless.

Doctor J. S. Rodman asked Doctor Frazier how much tissue he leaves in his subtotal thyroidectomy. The question was asked because he has had more post-operative thyrotoxicosis than he would like to have. He was amazed to see the amount of tissue which was removed by one of the surgeons he saw operate in Chicago, and the very small amount he left behind. He thought this had a lot to do with the fact that post-operative thyrotoxicosis was becoming much less frequent in his experience.

Doctor Frazier (in closing the discussion on his paper) said that at the recent joint meeting of the New York Surgical Society and the Philadelphia Academy of Surgery, in discussing the surgical treatment of paralysis of the recurrent laryngeal nerve, he had touched upon the technic of thyroidectomy particularly with regard to protection of this nerve.

The two most important points in the technic are the protection of the nerve and the amount of tissue to be removed. In his clinic a safety line is established and no tissue is removed below that level. On the inner aspect of the lobe the safety plane is on a level with the anterior surface of the trachea. If one observes this rule the recurrent laryngeal nerve will never be damaged.

With regard to the amount of tissue to be left; upon this depends the degree and the permanency of the improvement. The greater the degree of toxicity, the smaller the amount of tissue which should be left. As a matter of practice he leaves a thin layer of thyroid tissue in that portion of the capsule which is in relation with the larynx and a corresponding surface of the capsule on the exterior aspect of the lobe. He used to think that the more tissue he removed the less the immediate reaction would be, but since he had been practicing hemithyroidectomy in selected cases, where one entire lobe may be left, without apparent effect on the immediate post-operative course, they had had to change their minds.

CALCIUM AND PHOSPHORUS METABOLISM IN THE FRACTURE OF BONES

Doctors I. S. Ravdin and Leon Jonas read a paper with the above title, for which see page 37.

TRANSACTIONS
OF THE
NEW YORK SURGICAL SOCIETY

Stated Meeting Held April 14, 1926

The President, Dr. Walton Martin, in the Chair

RUPTURE OF SPLEEN

Doctor H. Fischer presented a boy, sixteen years of age, who, while coasting, hit a tree with his sleigh and was violently thrown to the ground, striking his left side. He was somewhat stunned, but did not lose consciousness; he immediately experienced a violent pain all over his abdomen and felt nauseated, but did not vomit. In spite of his great distress, he was able to walk quite a distance to his home. He went to bed, but instead of getting better his distress increased during the night, so that he was compelled to call a physician, who ordered some morphine. He was seen in consultation forty hours after the accident had occurred. Physical examination at this time showed a temperature of 100.2, pulse of 80, of good quality and regular. His face looked a little pinched and mucous membranes looked a little anæmic. The abdomen was slightly distended and extremely painful all over with board-like rigidity of the abdominal wall. It seemed that the greatest point of tenderness was more over the right side of abdomen than over the left side where he struck the ground in falling. There was dullness on percussion over both flanks which disappeared by changing his position, indicating free fluid in the abdominal cavity. The slightest change of position would cause him a great deal of pain and therefore, he kept an absolute rigid and stiff position in bed. There were no evidences of abrasions or discoloration present. It was evident that a serious injury to one of the abdominal organs had occurred, the nature of which, however, could not be illicited with any certainty.

The patient was removed to the hospital, and on his arrival about one hour later it was found that his pulse rate had risen to 120 and his temperature rose to 101.6. It was decided to do an immediate laparotomy with the tentative diagnosis of hemorrhage into the abdominal cavity caused by a probable tearing off of the gut from its mesentery. The reasons for this diagnosis were the signs of a hemorrhage into the abdomen after a blunt injury. This hemorrhage did not seem to be very abundant, as indicated by the general good condition of the patient. The rupture of any of the hollow organs could be excluded to a fair degree of certainty, on account of the lapse of time which had occurred since the injury. If an injury of that kind had occurred, the condition of the patient would be almost beyond hope on account of the development of a general peritonitis. A rupture of spleen and liver could not be entirely excluded. At no time after the accident had blood appeared in the urine, and as he had urinated normally, an injury to the kidney could be excluded. The boy had the greatest pain on the right side of the abdomen and therefore a right rectus incision was made.

Upon opening the peritoneum a large amount of bloody fluid escaped, exploration of the abdomen showed no sign of injury to the liver or to any of the intestines on the right side of the abdomen. On palpating, the spleen, a firm clot of fair size and a tear near the upper and inner border of this organ could be felt. Therefore, an incision was made on the left side of abdomen running from the xyphoid process along the left border of the ribs

down to the tip of the twelfth rib. Upon opening the abdomen about a handful of coagulated blood was removed between the spleen and the stomach and a stellate tear of the spleen was found at its upper and inner border which was partially plugged by a firm coagulum. From the lower part of the tear which was about an inch long a slow trickling of blood still continued. The spleen was enlarged and congested and was very firmly attached by adhesions at its upper pole to the diaphragm. Under the circumstances it was considered the wisest plan to stop this bleeding by a tampon of iodoform gauze as there seemed to be no indication to remove the whole organ. The wound was closed around the tampon by layer sutures of chromic gut and 1000 c.c. of Ringer's solution was administered intravenously. The first three days after the operation were rather stormy inasmuch as the temperature rose to 105, pulse sometimes reached the rate of 150–160. After the third day these symptoms subsided and the boy made a perfect recovery.

PULSATING EXOPHTHALMOS; LIGATION OF COMMON CAROTID

Doctor Charles H. Peck presented a patient who had received a head injury, April 25, 1925. After recovery from the immediate symptoms he complained of a bruit felt in the left temporal region synchronous with the pulse, especially troublesome at night when everything was still. He also noticed that the left eye was becoming more prominent. He came under the care of Doctor Tyson, at the Knapp Memorial Hospital, and was under observation for several months. Symptoms remained more or less stationary but did not improve. Examination shows exophthalmos of both sides, but greater on the left by 5 mm. There was no loss of vision, and no diminution of the visual field. Patient was referred for ligation of the carotid artery by Doctor Tyson on February 25, 1926, at which time examination showed the condition already mentioned, *i.e.*, exophthalmos greatest on the left side. A high-pitched whistling bruit, synchronous with the pulse, heard by stethoscope in left temporal region. The fundus of the eye and the visual field were normal. It was decided to try the plan suggested by Doctor H. Kerr, of Washington, and do a partial occlusion of the carotid artery, preliminary to its complete ligation to minimize the danger of cerebral accident. This plan was carried out and the partial occlusion was performed March 4, the complete ligation on March 25. The patient's subjective symptoms of the bruit disappeared after the partial occlusion, also the high-pitched bruit formerly heard, could no longer be recognized, although a soft, low-pitched murmur was still present, even after the second operation. The wounds healed per primam and patient was allowed to leave the hospital on Saturday, April 3, 1926.

On March 4, 1926, he was readmitted for operation and the left common carotid artery exposed. Band of fascia lata taken from left thigh, and passed around artery about one inch below its bifurcation. Diameter of artery measured before constriction .39 inch. Fascial strip doubled lengthwise was then brought about the artery and secured with fine chromic stitches, constricting the vessel until the external diameter was .18 inches; it was estimated that this reduced the cross-section area at this point by more than 80 per cent. Patient was relieved of the bruit and had no unfavorable symptoms during the procedure. On March 25, under novocaine analgesia, the second stage was done. Carotid artery exposed just below site of partial ligation. It measured 19/50 inches, the same as at former operation. The site of partial constriction was buried in firm cicatricial tissue. An attempt was made to clear the artery through this mass of tissue, but it was unsuccessful. Two heavy silk sutures were placed on the main vessel just below the

site of the former partial constriction. Patient bore the operation well. At the present time the patient is in very good condition. There is very little difference between the appearance of the left and right eyes and the bruit, no longer in the least annoying, has diminished to a faint murmur which can hardly be distinguished on examination.

CARDIOSPASM: DIGITAL DIVULSION OF TWO CASES

Doctor Charles H. Peck showed a male patient, aged forty-two, who gave a history of difficulty in swallowing, dating back eight years, with no pain, but considerable discomfort from the food retained in the dilated œsophagus. Is very nervous and worries a great deal about the condition. Appetite is abnormally good. Has been treated with bougies and antispasmodics without any permanent benefit. Lived in the tropics for a time, where his work involved great strain and responsibility. X-ray shows enormous dilatation of œsophagus and marked obstruction at the cardia.

On November 2, 1925, a gastrotomy was performed through a paramedian incision. The large dilated œsophagus projected about two inches below the diaphragm; the cardia sphincter being at this level. There was no apparent fibrosis or general thickening, the muscle was firm and hard. The stomach was opened two and one-half inches below the cardia and retrograde dilatation first made with bougies. With fingers in the stomach, digital dilatation of the sphincter was then made, until two fingers could be freely passed into the œsophagus and separated considerably. No further operative procedure was done. The gastrotomy wound and abdominal wound was closed. Recovery was uneventful, and patient was able to swallow solid food within a week after operation. He left the hospital on the twentieth day greatly improved. As to the ability to swallow, this improvement has continued up to the present time. Check-up X-rays taken March 9, 1926, showed marked lessening of the œsophageal dilatation, although it is still larger than normal. Has gained twelve pounds since leaving hospital. Has to eat slowly, beginning with fluid followed by solid food. Feels fine and works regularly.

The second case presented was a female, aged twenty-six, whose difficulty in swallowing dated back four years. Bloated feeling and vomiting four to five hours after meals. Pain in epigastrium and back, worse at night. Induced vomiting to relieve distress, often noted food taken twenty-four hours before. Symptoms worse for the past year. Weight 115 pounds, normal weight 145 pounds. X-rays showed greatly dilated œsophagus with delay in passage of barium into stomach. Dilated œsophagus seems to project below the diaphragm.

Operation April 11, 1925, through upper median incision. Stomach considerably prolapsed, cardia at least three inches below diaphragm, dilated œsophagus passing through an enlarged diaphragmatic opening which admitted three fingers: the opening was the shape of a transverse crescent with sharp anterior edge. There was no cicatricial thickening at the cardia. Gastrotomy performed and digital dilatation of the cardiac sphincter effected to about two and one-half fingers. Gastrotomy wound closed, no attempt made to narrow diaphragmatic opening. Left hospital on the twenty-second day feeling greatly improved and able to swallow much better. Six months later had gained twenty-five pounds, able to eat food without distress. Check-up X-ray taken April 2, 1926, does not show the improvement hoped for; the œsophagus is still greatly dilated and barium empties slowly into the stomach.

Doctor Robert T. Morris asked if Doctor Peck remembered the pulse rate in these cases, as it might serve as an index to vagus over-stimulation

or autonomic over-stimulation caused by some peripheral irritation producing spasm of the sphincter at the entrance of the stomach. The speaker had never seen such pronounced cases as these of Doctor Peck's, but in some of his cases of cardiospasm he had found that the peripheral irritation factor could be removed by attention given to an impacted molar tooth, nasal hypertrophies, or eye muscle imbalance, for example. Pylorospasm commonly depends upon an efferent impulse going from some afferent peripheral irritation below the diaphragm—loose kidney, gall-bladder irritation or pelvic adhesion, for example. In cardiospasm, on the other hand, the peripheral irritation sending afferent impulse might commonly be found at some distance above the diaphragm.

Doctor Charles Gordon Heyd said that he believed the cases presented by Doctor Peck might at some future time experience a recurrence of their symptoms. Two years ago the speaker had two cases, both with an S-shaped dilatation of the œsophagus through which no bougie could be passed *per oram*. In the first case an exploratory laparotomy was performed and a duodenal tube passed through into the duodenum and left *in situ* for feeding purposes. At the same time a retrograde catheterization of the œsophagus was done and a strong braided silk thread left in the œsophagus, passing from the mouth down through the œsophagus and out through the anterior abdominal wall. For three months œsophageal dilatation was carried out by the passing of graduated bougies. At the end of this time the thread was withdrawn and the patient has remained well since that time. She reports every three months for catheterization of the œsophagus.

The second patient was so extremely emaciated that a preliminary gastrostomy was performed. At the end of three months she had gained approximately sixty pounds in weight. The stomach was opened and a manual divulsion of the cardia performed. This patient has never been entirely well but is relatively free from discomfort, particularly if she eats slowly. Fluids give her more trouble than solid food.

Doctor Nathan W. Green said that he had had several cases of cardiospasm which he had treated as follows: Some were dilated with the Plummer-Vinson dilator, the Lerche mechanical dilator and the bougies, without relief of a permanent nature; he had to dilate some of them every three or four months. In one case there had been made a linear incision through the coats of the œsophagus as far as the mucosa but which still had spasmodic obstruction and had to be dilated quite regularly, another case had to be dilated every six months, another case has obstinate cardiospasm but goes for one year. The speaker could bear out Doctor Heyd's observation that these cases have to be followed regularly. Some of them have only been dilated by him once but he feels that these are cases that have been lost sight of. In consideration of Doctor Peck's cases one should recall the case Doctor Adrian Lambert reported some years ago in which he anastomosed the pouch of the dilated œsophagus with the stomach through the œsophageal opening of the diaphragm and obtained a good result.

Doctor Peck, in closing, said he did not remember what the pulse rate was, but that he had not noticed any slowing. Referring to Doctor Heyd's and Doctor Green's remarks, he himself thought it quite possible these cases would have further trouble. He had shown them merely as interesting cases in which digital dilatation had been done more to verify the diagnosis than as a desirable form of treatment. He did not consider these cases permanently cured, but they are relieved of very distressing clinical symptoms. There was no pathological lesion except cardiospasm and therefore no reason why they could not be relieved again in future, if necessary, by mere dilatation.

PARTIAL GASTRECTOMY FOR CARCINOMA

Doctor Carl Eggers presented a man, sixty-seven years old, who first came under observation at the Lenox Hill Hospital, February 26, 1925, with the history of pain in the upper right abdomen. For several years he had been treated in different clinics for chronic inflammation of the gall-bladder. Röntgen-ray examinations of the gall-bladder and the stomach in the latter part of 1921 had been negative. On admission he complained of pain in the upper right abdomen which had been constant for one year. It was dull in character and was associated with some radiation to the back. It was at times relieved by food. There was no vomiting. Occasionally he had slight regurgitation. His appetite was poor. Examination showed a poorly nourished, anæmic man, weighing 119¾ pounds. The abdomen was not distended. The suprapubic scar of a prostatectomy was well healed. He had a direct right inguinal hernia. The liver was palpable two fingers below the costal margin. There was tenderness over the gall-bladder region. No other organs or abnormal masses could be made out. X-ray examination of the gall-bladder, including a Graham test, were negative. The duodenal contents showed blood, but no other abnormality. Before a gastro-intestinal series could be done the patient developed mental depression sufficiently severe to make it inadvisable continuing the examinations. He was therefore discharged. He was readmitted November 23, 1925, stating that he had been fairly well through the summer and had increased his weight to 132 pounds. The last two months he had again begun to fail and on admission weighed 114 pounds. A large hard tumor was palpable in the right upper abdomen. It was slightly movable and appeared to be connected with the stomach. There was no vomiting, and no peristalsis was visible, gastric analysis showed no retention, there was an absence of free hydrochloric acid, and blood was present. The röntgenographic examination revealed a large filling defect of the lower third of the stomach, involving chiefly the lesser curvature, leaving a fairly clear canal along the greater curvature. The appearance was that of a lobulated mass, probably a new growth.

Operation performed November 30, 1925. Through a median epigastric incision disclosed no free fluid, no metastases but a large hard tumor occupying the lesser curvature of the stomach and extending to the pre-pyloric region. The pylorus was not involved. The lymph-nodes along the lesser curvature were involved up to the cardia, those along the greater curvature were likewise extensively involved. A typical resection was done removing at the same time all involved lymph-nodes. With great difficulty it was possible to reach the limit of the lymphatic extension at the cardia. The duodenum was divided just distal to the pylorus and the stump closed with two rows of sutures, the inner being composed of chromic catgut and the outer a purse-string of silk. The stomach was divided well beyond the limits

of the tumor and its end closed by two rows of sutures. The remaining stump of the stomach was very small and it was difficult to do a posterior short loop gastro-enterostomy. This had to be done without the aid of clamps. The stoma was then fastened in the opening of the transverse meso-colon by interrupted plain catgut sutures. Abdomen closed in layers, using three heavy silk through-and-through sutures in addition to the layer sutures. During the operation an hypodermoclysis of 1000 c.c. was given. The patient reacted well from the operation and is to-day completely relieved of his symptoms and able to eat everything. An X-ray taken some time after operation shows the stomach to be empty after four hours. . . . The pathological report (Doctor Fred Bullock) was adeno-carcinoma with large areas of suppuration. Sections of twenty lymph-nodes showed no evidence of secondary tumor deposits. Such a report is encouraging and teaches one not to be too pessimistic in the presence of a palpable stomach tumor. Palpability is not a contra-indication to operation, one may frequently find that such a tumor is quite movable and easily extirpated. In the same way the presence of enlarged hard nodes should not influence one against operation if the tumor itself can be removed, for the enlargement may be due to absorption from an ulcerating carcinoma. That is probably the explanation in this case, in which all twenty nodes removed, though large and hard, showed no metastases.

Doctor Charles H. Peck said that he had a case in 1924 of very extensive carcinoma of the stomach with glandular involvement relieved by resection. The patient is still perfectly well after sixteen months and is an example of what Doctor Eggers meant when he said that it is worth while, in some of these seemingly hopeless cases, if the tumor is movable, to take the risk of resection.

Doctor Fordyce B. St. John said that he was very much interested last year, in reviewing 99 cases of carcinoma of the stomach operated on at the Presbyterian Hospital in the last seven years, to find that 75 per cent. of those explored had been considered inoperable at the time of admission to the clinic. But the only case alive after five and one-half years was a man on whom Doctor Adrien Lambert operated and who had a very large tumor, diagnosed adeno-carcinoma. It raises the question of the result of those large localized growths in the follow-up and in some cases the question of better prognosis in the large local carcinomata.

Doctor Hermann Fischer said that a seemingly inoperable tumor can sometimes be operated on with considerable success, but an opinion to the contrary seems to prevail among general practitioners who almost invariably advise their patients against surgical relief in large carcinoma of the stomach. The degree of malignancy in these tumors is very different. Several years ago a patient was referred to the speaker who had a tumor of the stomach almost the size of a child's head, in which the question of operability was doubtful. The patient decided to take the risk and no trouble whatever was experienced in resecting a huge tumor of the stomach. The man made a perfect recovery and this was a matter of great importance to him, for at the time of operation he had suffered reverses in business, but afterward his circumstances improved, he was able to go comfortably about his work, and

when recurrence finally took place at the lesser curvature four years later, he was able to leave his family in very good circumstances. As we have no means at our disposal to establish the operability of a large carcinoma of the stomach except by an exploratory laparotomy, it is my opinion that every patient should have the benefit of such an operation.

PULMONARY FISTULA FOR CHRONIC LUNG ABSCESS

Doctor Carl Eggers also presented a young man, twenty-nine years of age, together with a series of X-ray plates illustrating his condition over a period of five years prior to operation, and since that time. The patient first came under his observation in February, 1924, with the history of having developed pleurisy on the right side in August, 1919. He was tapped twice. Some time later pneumonia was diagnosed and he was admitted to the Lenox Hill Hospital, where the diagnosis was changed to lung abscess. His physical signs at that time were decreased resonance and breath sounds over an area roughly corresponding to the middle lobe. Expansion was restricted. The temperature did not go above 100. The sputum was copious and at times as much as 90 c.c. was expectorated at one time. It was negative for tuberculosis and there were no elastic fibres. Under rest treatment and bronchoscopic therapy improvement took place and the patient was discharged October 12, 1919. Since that time he had been frequently readmitted for bronchoscopy, and Röntgen pictures were taken at long intervals. In spite of the fact that he was ambulatory and doing quite well, he had never been completely relieved. There was always cough and expectoration, and the patient felt weak and had profuse sweats. He stated that since his last bronchoscopy about five months prior to his admission in February, 1924, he had had no foul expectoration, but that he had frequent pulmonary hemorrhages, sometimes as often as three or four times a day. Each time he brought up from 50 to 100 c.c. of clotted blood. The hemorrhages were often followed by nausea and vomiting.

On admission there were signs of a cavity in the middle lobe or upper part of the lower lobe. Bronchoscopy was negative. Operation was decided on, the details to depend on the findings.

February 11, 1924, under local anæsthesia, the entire cartilage and one inch of the fourth right rib were resected. The internal mammary vessels were doubly ligated and divided and the parietal pleura separated from the chest wall for some distance. It was noted that the lung was not adherent. No puncture was made, therefore, but iodoform gauze packed against the pleura to favor adhesions with the lung. The patient developed a postoperative pneumonia at the left base which, however, did not seriously interfere with his convalescence. On February 23, 1924, the second stage was done. Tampons removed. For better exposure an additional two inches of the fourth rib were removed, as well as the entire cartilage and a part of the fifth rib. Exploratory puncture revealed thick, greenish pus. The needle was left *in situ* and a Paquelin cautery passed alongside it into the cavity. The latter was then unroofed, revealing a smooth trabeculated cavity the size of a walnut, showing several bronchial openings. There was brisk hemorrhage from the divided fibrosed lung tissue which could not be controlled with the cautery. Deeply placed hæmostatic sutures were necessary to stop it. The cavity was packed with iodoform gauze and the wound left open. Convalescence was uneventful. There was at first considerable discharge, which later diminished in amount and became more mucoid. At present there is no discharge at all and no dressing is required. The wound

has contracted and only a small bronchial fistula remains, through which retrograde breathing is possible. Immediately after operation the pulmonary hemorrhages ceased, expectoration rapidly diminished, and the cough disappeared entirely. Except for the bronchial fistula, the patient is entirely well.

LIPOMA OF LARGE INTESTINE—RESECTION

Doctor John Douglas presented a female, age forty-one, admitted to St. Luke's Hospital in July, 1925, complaining of pain in the lower abdo-

Fig. 1.—Lipoma of large intestine. Tumor has been cut through.

men, constipation and abdominal distention at times. A mass could be palpated in the left inguinal region, and radiographic examination showed a filling defect in the sigmoid flexure. She had several years previously been operated on for a tubo-ovarian abscess in another hospital. A diagnosis of

carcinoma of the sigmoid was made. At operation, what was believed to be an annular carcinoma of the sigmoid flexure was found, and a resection of about 16 cms. of the intestine performed with an end-to-end anastomosis. It was not until the specimen of the intestine was opened that it was found that the tumor was a sub-mucous lipoma (Fig. 1), which partly obstructed the lumen of the intestine, and which had ulcerated through the mucosa. The convalescence was uneventful for nine days, the bowels moving after the third day by means of an injection of two ounces of equal parts glycerine and water. The wound healed by primary union. On the ninth day, following an enema, there was acute abdominal pain, rigidity and an elevation of the temperature and leucocyte count. A laparotomy was again done four hours later, and a small perforation found on the mesenteric border at the line of union. A small fistula followed this operation, which remained open until January, when an operation was again done to close this fistula; this being successful.

In the *Journal de Chirurgie* of August, 1924, vol. xxiv, p. 163, P. and A. Derocque, after a thorough review of the literature, collected 104 cases of lipoma of the intestine and added one of their own. In only seven were multiple tumors found. The tumors were symptomless in 34 per cent. of these occurring in the small intestine, and in 9 per cent. in the large intestine. In thirty-one cases, acute occlusion occurred, and in fifty-six cases, chronic symptoms were caused. In the seventy-two tumors causing symptoms, intussusception had occurred in 88 per cent. of the thirty-two small intestine cases, and in 50 per cent. of the thirty-eight large intestine cases.

POST-OPERATIVE STRICTURE OF THE HEPATIC DUCT

Doctor John Douglas presented a female, aged thirty-two, who had had a cholecystectomy done elsewhere in June, 1924. There was no jaundice after operation, but on the tenth post-operative day, she had fever which lasted for twelve days, although the wound healed by primary union and there was no biliary discharge. She remained in the hospital for four weeks, remaining well for four months, when she began to get jaundiced and have chilly feelings at times. At the time of her admission to St. Luke's Hospital in December, 1925, her icteric index was 167. At operation, there was a complete separation of the upper end of the common hepatic duct. There was a small nipple occupying the transverse fissure of the liver, consisting of the right and left hepatic ducts, which were separated from each other by a septum, so that aspiration of one did not empty the other. The upper end of the common duct was found, isolated, brought up and sutured to the stump of the two hepatic ducts, after dividing the septum separating them, using a "T" tube, the upper limb of which was cut into a "Y" so as to enter each duct separately.

The patient was well until late in June, five months, then began to have jaundice again with some signs of cholangeitis. This condition continued until November, in varying degrees, with a bile index which varied from 27 to 38—during which time she received large doses of bile salts but which finally subsided, and she has now been free of jaundice for the past five months. Her bile index on April 2 was 9. Two weeks ago, a therapeutic abortion was done on this patient at the second month. Although she was not jaundiced at the time, it was believed by the writer, which belief was concurred in by the members of the Surgical Staff in conference, that the danger of a recurrence of her symptoms, due to the chances of infection of the liver, together with the increased cholesterinæmia which accompanies pregnancy, occurring such a short time after her last symptoms, would endanger her life.

This action was prompted by previous experience with another case who was allowed to go through with her pregnancy, although she was having symptoms from an injury to the duct and was jaundiced, which jaundice became so severe by the time she returned to the hospital after her labor, that she died, following a drainage operation of the duct, before any repair could be attempted; and also, due to the fact that these biliary duct repair patients, contrary to what has been written and reported, are very apt to have a recurrence of their symptoms.

A second case was also presented of a female, aged sixty, who had been shown before the New York Surgical Society on December 14, 1921, and reported in the ANNALS OF SURGERY, vol. lxxv, 1922, p. 381. Her reconstruction operation had been done in October, 1921. A suture of the duct high up to the point of union of the right and left hepatic ducts over a "T" tube. The stricture followed operation for a gangrenous gall-bladder with stones in the common duct, and cholangeitis. When presented before the Society, two months after operation, she was apparently well, but as is the history of so many of these cases, in October, 1922, she again became jaundiced, had clay-colored stools and marked itching of the skin. She was given bile salts and this condition subsided, but until May, 1923, for a period of nine months, she would have attacks about once a month of pain and two days later would get somewhat jaundiced. Since May, 1923, however, she has been free of attacks and, while at times, her sclera have been slightly yellow, she has had no other symptoms and has gained fifty pounds in weight. It is now four and a half years since her repair operation.

It would appear from the history of these two cases, together with a study of nine other cases which have been operated on at St. Luke's Hospital for traumatic stricture of the bile ducts, and a review of the published case reports where there is a follow-up in the histories, that a recurrence of symptoms after these operations is very common, and that this recurrence depends on one or two factors or frequently a combination of both, that is—a narrowing of the stricture, a recurring cholangeitis and a thickening of the bile with a deposit of inspisated bile, sand, mucus, muddy material or even small stones behind the obstruction. Both of these cases reported showed these recurrences of symptoms, with both signs of obstruction and infection at times, and both have been aided and improved and are now symptom-free, following the use of continuous doses of bile salts, although it looked at times as though another operation would be necessary.

SUPRACONDYLOID FRACTURE OF THE FEMUR IN A CHILD—END RESULT

DOCTOR DOUGLAS presented a female, aged ten, who was admitted to the Knickerbocker Hospital in October, 1922, with a supracondyloid fracture of the femur. Repeated efforts were made to reduce this fracture by traction and manipulation under anæsthesia without success. Skeletal traction was not employed, because of the age of the child, the fear of injurying the epiphysis and the danger of infection due to the condition of the skin, where tongs or a pin would have been inserted. Finally, when callus began to appear as shown by the radiograph, as the fragments were still in bad position, open reduction was considered. This was not advised, as it was believed that nature would take care of this deformity. That this view was justified is shown by the end result two and a half years later. There is no limp, there is perfect function of the knee-joint, and the radiograph shows restoration to an almost normal contour of the fractured bone. Measurement shows about 2 cm. shortening, which it is believed will entirely disappear as

the child attains her full growth. This case is not shown to advocate carelessness or failure to employ every effort to attain the most perfect reduction possible, but to demonstrate what nature can do in the fractures of children, and that it is probably safer to depend in most instances on nature in fractures in children, than to run the risk of open operation, particularly in the neighborhood of the joint or epiphysis.

Doctor Whitman said he thought that the favorable result might be explained by the fact that the fragments were fairly aligned and that the fracture was sufficiently far from the joint as not to interfere with motion. Fractures of this type if treated before the formation of callus might be easily apposed by an open operation and he thought such a procedure was usually indicated.

Doctor Douglas, in closing, repeated that open operation had been considered in this case, and also the use of skeletal traction, but the child had been in a run-over accident and the skin had been abraded, and the chances of infection following operation would have been considerable. With infection the prognosis would not have been as good at that time, and the final result surely would not have been as good at the present time.

THE SURGICAL TREATMENT OF ACUTE APPENDICITIS

Doctor Edward D. Truesdell read a paper with the above title, for which see page 104.

Doctor Robert T. Morris said that many years ago, according to principles of the third era of surgery, the surgeon himself was supposed to dispose of bacteria or their products without much regard for the patient's own resistance factors. Under third era methods the surgical death rate in acute appendicitis was so great that some of the Chicago surgeons at one time were in favor of waiting for the interval stage before operating. Some hospitals showed a death rate of from thirty to forty per cent. in these cases. Composite statistics from hospital reports secured from a number of cities at that time showed an average surgical death rate of seventeen per cent. in acute appendicitis cases. Under the principles of fourth era surgery the death rate now remains below four per cent. in many hospitals. The avoidance of trauma, short incision, speedy operating, keeping gauze packing out of the abdominal cavity, and avoidance of flushing and wiping should at least keep the death rate below five per cent. One advantage in using McBurney's incision is that different muscle layers may be sutured separately. They have different lines of traction. If this mechanical point is not recognized hernia will occur more frequently. Concerning inversion of the stump simple ligation should suffice and be better. The appendix is a vestigial organ and opening of the stump after ligation does not occur as it certainly would after ligation of an oviduct, and as it commonly would after a ligation of the cystic duct of the gall-bladder. Post-operative bleeding into the bowel is commonly due to ballooning of the cæcum. With the cæcum filled with gas almost any sort of ligature or suture may cut out from the appendix region and this is particularly a danger when the unnecessary technic of burial of the stump

is employed. As to hypodermoclysis, the Murphy drip is better. As to the rubber dam drain, why not add a little strip of gauze to it and increase the capillary power by making a wick. Morphine is of great advantage in some stages of acute appendicitis in order to halt peristalsis and allow the infected area to become walled-in. This was the principle in the Ochsner starvation method. Mistakes in diagnosis should seldom occur at the present time. In acute appendicitis in its early stages at least there should be tenderness on deep pressure of McBurney's point and nowhere else. In chronic appendicitis there should be tenderness on deep pressure over the fused ganglion of the right side and nowhere else.

Doctor Seward Erdman remarked the mortality rate being rather below the usual 4 to 5 per cent. Such a selected series, however, may not always be a true reflection of the total consecutive admissions for a given disease, into any one hospital over a stated period. He had recently gone over the acute appendicitis records of the Second Surgical Division of the New York Hospital for the past decade, and was impressed by the very great variation in mortality from one year to another. For one year the mortality was less than 2 per cent. and the next year it was over 8 per cent., despite the fact that the same staff were operating and the methods used were practically identical. This would seem to show that the desperate cases often come in unexpected groups. Regarding post-operative herniæ after appendectomy, Doctor Truesdell replying to the question, said that he had followed up 75 of his cases by reëxamination and had discovered six herniæ, or 8 per cent. In 1920, Doctor Bancroft reporting from the New York Hospital on " followed cases " only, found 9.8 per cent. herniæ in 500 cases of acute appendicitis operated and traced; the drained cases gave 15 per cent. herniæ, the cases not drained gave 1.9 per cent. Doctor Erdman would call attention of surgeons to the large number of incisional herniæ which are encountered in this day of extensive abdominal surgery. Of all admissions for hernia, including all varieties, on the Second Division New York Hospital, one case in twelve was a post-operative hernia. Masson of the Mayo Clinic, in a similar study, found one case in seven was an incisional hernia. From the Ruptured and Crippled Hospital reports by Coley, etc., there was found only one incisional hernia to 60 other herniæ, which is a very great discrepancy from the Mayo Clinic, but is readily explained by the small amount of abdominal surgery performed at a specialized hospital such as the Ruptured and Crippled.

Doctor Edward W. Peterson commented on Doctor Truesdell stressing the incision more than any other point in his paper. The speaker had used the McBurney, the Deaver and Kammerer incisions until he was impressed on reading a paper by Stanton, of Schenectady, who sent out a questionnaire and found the McBurney incisions yielded a larger percentage of hernias in drainage cases than the Deaver or the Kammerer. The speaker's preference is for the Kammerer, for he believes that fewer hernias follow it than either the Deaver or McBurney. Stanton's figures indicate that.

Doctor Frederic W. Bancroft said that he had found 13 per cent.

developed hernias following the McBurney incision and 20 per cent. right rupture. Doctor Farr reported a series of Mikulicz's drain in which 17 to 18 per cent. resulted in right rupture. There is not much to choose from in those two incisions but the McBurney is preferable to the right rectus incision and the hospital stay is shorter with the McBurney.

Doctor Frank S. Mathews said that on the basis of recent statistics from a large number of hospitals and 11,000 cases, a mortality in chronic appendicitis of 2 per cent. had been claimed. Since there is a distinct mortality in chronic appendicitis, it is interesting to note that in Doctor Truesdell's acute cases, the mortality is only 4 per cent. There would be some advantage in considering the mortality separately for the drainage and non-drainage cases since nearly all of the mortality is to be expected in the drainage cases. Referring to the propriety of enterostomy, that is, ileostomy or jejunostomy, he said that he was almost without experience. In looking over the mortality in his own cases, he has found a number of them due to such complications as diabetes, and he was unable to recall a case where he felt that an opening of the bowel would have changed the result. He mentioned two cases with abrupt improvement following spontaneous development of a fistula. Subsequent operation in each showed the fistula to be in the small intestine. His impression was that each was a case of obstruction from angulation due to including the wall of the bowel in the suturing of the abdominal wound.

Doctor John M. Hanford said it was difficult as yet to state facts about the value of jejunostomy; but as a preventive of, and a therapeutic agent for, paralytic ileus in acute diffuse peritonitis following acute appendicitis, it should be considered of possible influence in certain cases and be done at the time of the primary operation. Particularly in late cases and in those with intestinal distention at operation, it would appear to be indicated.

Doctor Harold E. Santee said that apropos of distention, ante-operative and post-operative in non-toxic cases, he would like to call attention to the work of Doctors Soma Weiss and Hayes Martin published by the American Medical Association in 1925 on the use of physostigmine. When the speaker was in Presbyterian Hospital in 1910, the use of this drug in doses of one-sixty-fourth of a grain was routine and apparently without effect. Since the work of the above men in the Hatcher laboratory on cats and their work on our wards at Bellevue, we have used the drug in doses of one-sixteenth to one-twelfth of a grain in some cases with salutary effect. It is a useful adjunct to the other measures employed in this condition.

Doctor Henry W. Cave said that he now had a patient at Roosevelt, a young girl who came in with a ruptured appendix. At operation the appendix was not removed, but drainage was made and the fluid suctioned from the pelvic cavity. Four days afterward she got up an acute ileus and jejunostomy was performed. The jejunum was markedly dilated. She subsequently made a good recovery. Another case, a boy of fifteen was operated on four months ago for acute appendicitis and the appendix was

removed. On the twelfth day he got up a paralytic ileus and jejunostomy was done and he recovered.

Doctor Walter M. Brickner said that the use of the suction apparatus for the removal of pus or blood from the abdominal cavity, referred to by Doctor Truesdell, cannot be commended too highly. It is more thorough and less traumatizing than sponging and to the extent that it is time-saving it is also sometimes life-saving in urgent cases, the assistant can suck out each pocket while the operator is dealing with the appendix or other diseased organ. He would like to ask Doctor Truesdell, however, whether he removes the thin non-purulent fluid exudate often seen in acute appendicitis, which fluid is regarded as bactericidal. The danger of erosion of the deep epigastric vessels by a drain is a very real one. The speaker had two experiences of secondary hemorrhage from that source, and since then he has made it a routine practice to tie off the epigastric artery and vein in the upper and lower angles of the wound whenever he introduces a drain through the rectus-splitting incision.

Doctor Truesdell, in closing the discussion, said that at the beginning of his paper he explained he was just starting to investigate his appendicitis cases of the last sixteen or eighteen years, but this paper is based on the records of only the last seven years. All the facts have not yet been worked up, such as the matter of hospital stay, mentioned by Doctor Bancroft; the bearing of this is quite important. As Doctor Morris said, the inclusion of gauze with the rubber dam might be a very good thing. He had been afraid to use gauze in the abdomen, but did not see why it could not be employed to advantage in the rubber dam. As to Doctor Erdman's remarks about the death rate, it is true that it seems to be a matter of luck what sort of cases one strikes. In regard to his own mortality rates in children under ten years of age, 18 per cent. died at that age or under, four deaths in 220. Taking the cases of two years of age and under, there were seven with three deaths, a mortality of 43 per cent. In regard to hernia the figures are not quite complete. As many as possible of the cases that had been drained had been followed, but they have not all as yet been seen. In regard to enterostomy, the speaker had not condemned it, but his cases had not turned out to be the ones he employed it on. Answering Doctor Brickner, he always removed thick, foul-smelling fluid, but when it was merely cloudy he did not remove it.

CORRESPONDENCE

TWO CASES OF DIAPHRAGMATIC HERNIA

EDITOR, ANNALS OF SURGERY:

Sir:

THE following report of cases of diaphragmatic hernia, though not as complete as might be wished, and with a fatal result in each case, are submitted as a contribution to the literature of the subject.

CASE I.—In December, 1925, there was admitted to the Central Maine General Hospital, Lewiston, Maine, a woman thirty-five years of age who, for the preceding year and a half, had been losing weight and strength and had suffered from digestive disturbances causing diarrhœa attended by much nausea and vomiting. To this was later added dyspnœa. At the time of her admission she was complaining of intense pain referred to the pit of her stomach and also pain in her right shoulder. She gave a history of always having been frail and with frequent illnesses affecting the gastro-intestinal tract. At time of admission, physical examination of chest showed heart displaced to the right of the midline; the right chest was otherwise normal; the left chest was, at times, dull to percussion and at other times tympanitic; the abdomen was flat; pelvis was normal. On the day following her admission, an exploratory laparotomy was done. The section revealed that the entire mass of small intestine with its mesentery were herniated into the left chest; the stomach and the liver were prolapsed; the spleen was enlarged and prolapsed into the pelvis. In the right axilla was seated a hard growth which was found, at subsequent microscopical examination, to be a non-malignant fibroadenoma. Subsequent to the operation, the patient was the subject of persistent emesis; temperature ranged from 99 to 101 degrees; pulse from 120 to 130 with respirations about 30. She gradually sank with no relief to her symptoms and died by exhaustion on the afternoon of the fifth day after operation.

Post-mortem Findings: Abdomen.—Liver enlarged, the anterior margin of the right lobe extends down as far as one inch above the crest of the ilium. The upper border of the liver is apparently normal. The diaphragm, on the right side, is at the level of the fifth interspace. There is no omentum or large intestine anterior to the surface of the stomach, nor can any small intestines be found in the abdominal cavity.

On the left side is a large hollow viscus, apparently the stomach, extending from the opening in the diaphragm in the fifth interspace down to and completely filling the pelvis. The stomach is more or less of normal shape; but what is apparently the pylorus is bent at right angles to the pyloric end of the stomach. The gastric omentum forms a complete sac, enclosing the stomach completely. The stomach is much enlarged; the pyloric opening was found at the brim of the pelvis. The duodenum makes a right-angled bend along the posterior surface of the stomach. Tracing the bowels upward from the pyloric end of the stomach, the duodenum runs posteriorly along the posterior wall of the stomach, is adherent to the œsophageal end of the stomach and is attached to the head of the pancreas.

Left Chest.—There is an opening in the left diaphragm, sufficient to admit the whole hand. Through this opening passed the second part of the small intestines, so that the third part of the small intestines, and all of the large intestine, except the descending colon, are above the diaphragm. The small intestines are matted together in a large sac. It is suggested that the sac, containing the small intestines, is a part of the pleura.

The mesentery of the large intestine is attached to the second rib in the mid-axillary line.

The descending colon is much atrophied in its lower two-thirds and passes through an independent opening in the rudimentary diaphragm on the left side. This large sac,

when opened, is found to contain small intestines coiled comparatively tightly and which show evidences of obstruction and congestion.

The left lung occupies the space from the first rib to the second costal cartilage. It is compressed and probably never functioned.

The spleen is enlarged and elongated; otherwise is apparently healthy. It is found three and one-half inches below the left costal margin.

Right Chest.—The left border of the heart is one inch to the right of the midline. Apex beat is in the nipple line, on the right side of the body. Heart is very much smaller in size than normal. Pericardium is apparently thickened (was inadvertently opened so it can not be said whether it contained free fluid or not). There is considerable evidence of fatty degeneration of the heart. Valves of the heart are normal.

The right lung is strongly adherent to the chest wall. The right lung, on its inferior surface, cannot be separated from the diaphragmatic pleura.

Right kidney is two and one-half inches lower than normal. It is free and movable. Perinephric fat is normal in amount. Right kidney is normal in size and apparently healthy. Left kidney is normal. (Figure 1.)

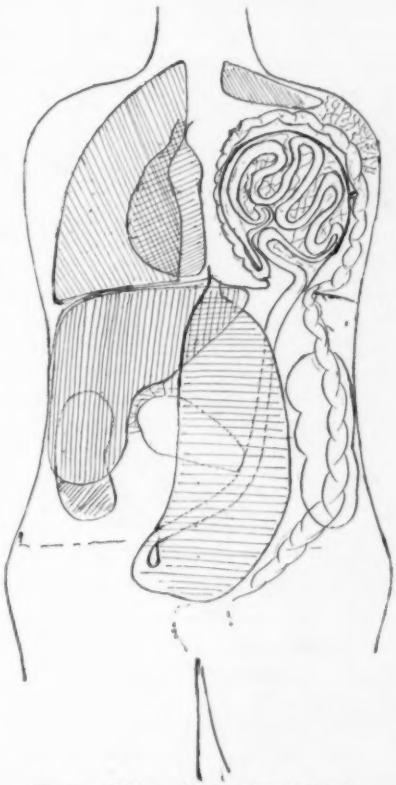

FIG. 1.—Schematic drawing indicating relationships of viscera, from autopsy on patient December 14, 1925.

CASE II.—On December 30, 1925, there came under our care, a woman forty-six years of age who, five days previously had exerted herself violently in running and during her run had slipped and fallen. Subsequent to this, she had eaten nothing except a half banana; bowels had not moved since the day preceding the effort at running, December 22. December 25 she developed violent pain in the epigastrium with nausea and vomiting; controlled by hypodermic of morphia; enemata were fruitless. She was removed to the Rumford Falls General Hospital where the abdomen was opened by a midline incision extending from ensiform to navel. This incision revealed that the transverse colon together with the whole of the omentum had gone through an opening in the diaphragm into the left chest and were there strangulated, the colon being of a very dark color. The hernia ring was cut and the hernia reduced and the rent in the diaphragm closed with interrupted sutures of chromic catgut. Gas distending the colon was removed through a trocar before the gut was reduced. Three hours after the operation, enemata gave results. The course of convalescence was uneventful until January 8, 1926 when the wound opened and drained freely for forty-eight hours; vomited once on January 10 and 11. From January 12 the vomiting became persistent and continuous and hernia had formed in the site of the wound. Enemata were unsuccessful. January 15 the wound was reopened for the division of adhesions and for securing more satisfactory closure. Following this procedure, the abdomen became markedly distended, nausea and vomiting persisted and the patient died at the end of thirty-six hours after this second operation.

WALLACE E. WEBBER, M.D.,
Lewiston, Maine.

ACUTE ILEUS FROM A DISTENDED BLADDER

EDITOR, ANNALS OF SURGERY:

Dear Sir:

THE following case has been considered worthy of publication because of the rather unusual pathology in its relation to the symptoms and physical signs as they presented themselves. In the production of an acute mechanical ileus the existence of post-operative adhesions and bands or the presence of some adjacent or overlying tumor—either intra- or extraperitoneal—are recognized as being among the most frequent causative factors. Here there was a combination of these, as the tumor in this instance was a distended urinary bladder held and incarcerated against the sacral promontory by adhesions resulting from a former operation. Furthermore there was the added complication of acute alcoholism, which probably played no small part.

Although no exhaustive study of the literature has been made, two cases have been reported within the past few years which might be mentioned in passing. In the first, described by McCoy, a boy of sixteen had had recurring attacks of pain in his left flank over a period of ten months with signs of partial ileus. At operation a large hydronephrotic left kidney was found; this had so impinged on the splenic flexure and descending colon as to cause an almost complete obstruction.

The second case was reported by Morsell. Here the patient was a man of forty-one. During the twelve months preceding operation there had been frequent attacks of obstruction and a movable tumor just above the bladder had been noted, which, however, became softer after the cessation of the attack. At operation a prolapsed hydronephrotic right kidney was found, resting against the rectum.

Neither of the above, it will be noted, is at all similar to the present case, and in both of these instances the tumor was distinctly pathological rather than physiological.

Alex D., was admitted to Bellevue Hospital in the evening of July 13, 1924, in alcoholic coma. He could be aroused with difficulty but was unable to give any account of himself other than his name. Physical examination was entirely negative except for an old lower right rectus operative scar. No paralyses were present; all reflexes were normal. On July 14, he appeared to be recovering from his acute alcoholism and at that time the only history of any importance that could be elicited was that he had been operated upon for acute appendicitis six years previously. He was obviously of poor mentality. His bowels had not moved since admission but he was reported to be voiding apparently normally. On July 15, he complained of a feeling of fulness in his epigastrium and later in the day began to have griping pains across the upper abdomen, particularly in the right hypochondrium. During the day he vomited at intervals a watery, greenish, sour fluid. A colonic irrigation returned clear—without feces or flatus. On the morning of July 16, his condition was about the same except that his abdomen was now becoming distended and was everywhere tympanitic. Rectal examination negative. Temperature normal; pulse 86; leucocytes 13,600, polymorphonuclears 91 per cent., lymphocytes 8 per cent., transitional cells 1 per cent. Turpentine stupes, an oxgall enema, and 1 c.c. of pituitrin gave no results whatsoever. A diagnosis of acute ileus, either paralytic or due to a band from his previous appendectomy, was made and operation decided upon.

Operation July 16, ether anæsthesia. The patient took a stormy anæsthetic throughout. Right rectus incision just mesial to the previous one. On opening the peritoneum adhesions between it and the omentum were found all about the old scar and extending down to the top of the bladder, where they were very dense. The bladder itself was markedly distended, but, due to the adhesions just described, this distention occurred for the most part in an obliquely upward and backward direction so that the resulting "tumor" impinged tightly against the rectum at the sacral promontory and thus produced a complete obstruction at this point. The rectum below was quite collapsed, whereas proximally the entire large and small intestines were much distended. As the adhesions were freed and the bladder lifted forward, the patient passed a small amount of flatus. His condition suddenly became very poor, so he was immediately catheterized, following which he improved and passed more gas by rectum. With the obstruction thus entirely relieved, the abdomen was quickly closed, during which procedure flatus was intermittently expelled in small amounts. The patient returned to the ward with a pulse of 90 and of good quality and with his distention noticeably less. He improved throughout the day and evening but unexpectedly collapsed and died early the next morning.

Autposy showed an acute pulmonary œdema with beginning bronchopneumonia, and also a severe chronic cystitis.

In view of the operative and necropsy findings a logical sequence of events might be built up somewhat in the following manner. First, we had to do with a man with a well-established chronic cystitis. During his alcoholic coma his already diseased bladder became over-distended with resulting paresis. What appeared both to him and to us as normal micturition proved to have been merely the spilling over of a distended and paralyzed bladder. We were further misled because of its abnormal position, for, as it filled, its normal rise was prevented by the dense post-operative adhesions about it. The resulting distention occurred, therefore, mainly backwards so that as the bladder became full it impinged with increasing pressure against the upper rectum at the promontory of the sacrum until a complete obstruction was produced.

It is scarcely conceivable that such adhesions alone would or could have produced this condition in a normal individual. Here, however, the patient was in alcoholic coma to begin with and this and his cystitis combined with the adhesions to bring about the final result.

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BOOK REVIEWS

"Injuries of the Wrist," "A Radiological Study." By the late Dr. Etienne Destot, of Lyons. Translated by F. R. B. Atkinson, M.D., C.M. 12mo, pp. 169. London, Ernest Benn.

Destot's volume on injuries of the wrist marks a great advance in the more recent carefully detailed study of sprains and fractures. He had a remarkable experience and an unusual mass of material from which he was able to prove to his own satisfaction the nature of wrist-joint injuries, their etiology, their natural history, and their treatment. This small volume is remarkable for its detailed consideration and yet for its conciseness of expression. Naturally one cannot agree with all Doctor Destot's conclusions, but considering his great experience and his exceptional ability, one must take his views with great respect.

This book is of course invaluable for the specialist in fractures and orthopædic surgery. For the general practitioner such a book, even if only casually read or inspected, would inspire an increased respect for the handling of sprains and fractures. This is much to be desired.

The book is well translated. Most of the illustrations are clear and convincing. Some of the line drawings are not so impressive. This book is well worth a place in the library of any progressive physician. It is only a question of time when similar books will appear for the other major joints, and it is to be hoped that these books will be written by as enthusiastic and capable men as the book of the wrist has been.

Charles E. Farr.

Emergency Surgery. By George DeTarnowsky, M.D. Lea and Febiger, Philadelphia, and New York, 1926.

It is seldom that one has the opportunity of reviewing a subject presented by an author whose qualifications are so preëminent in the subject considered. Colonel Tarnowsky's personal, varied and extensive service both with the French and American troops and the opportunity of studying the confidential data of the Allied Armies in preparing the chapter on Surgery of the Front in the Medical and Surgical History of the World War certainly has fitted him to present to the medical profession the most acceptable methods of dealing with surgical emergencies.

The number of injuries as the result of industrial accidents have been rapidly increasing and the medico-legal aspects involved have developed the treatment of these conditions into a definite specialty. Therefore, it has become essential that the standardization of the best, quickest and most efficient manner of caring for this class of case be effected, since the two desiderata pertinent during the war, namely the return to duty as soon as possible and the rehabilitation of the injured, hold equally true in civilian emergency as well.

The subject-matter presented is essentially practical, terse and unencumbered by theoretical discussion and irrelevant minutiæ. There has been eliminated much of the usually reiterated material so noticeable in many preceding treatises on this subject and very evident attempts to harmonize procedures with physiological and bio-chemical questions involved has been accomplished.

Possibly the outstanding advances to be noted are the more accurate localizing of foreign bodies and the direct visualization methods for their removal; the estimation of cranial injuries based in terms of neurological disturbance with an exhaustive table of instructions as to how this may be most accurately determined; the Cushing method of catheter suction of macerated brain tissue and spicules; the observations of Depage on the treatment of intra-articular lesions and the early mobilization of joints; the advances in intra-thoracic and general plastic surgery; the importance of immobilization of wounds and the administration of antitetanic serum.

The chapter on treatment of burns is particularly informing. It is interesting to note that he does not mention the employment of oil at any stage. Similarly the chapter on antiseptics reflects the advanced ideas of the author and his recommendation for the more extended use of ether as an antigressin of the utmost importance is noteworthy. Certainly those who have used it will agree with him.

The book consists of twenty-six chapters covering the various classes of injury which the body may sustain. In the consideration of each subject the author's methods and procedures which he has found to be most practicable are outlined—others which have not proven of value are eliminated. The text is illustrated by three hundred and twenty-four engravings. Many of these, however, are very badly reproduced owing to the poorly calendered paper. This is to be regretted as many of those noted as defective are germain to the text. It might be suggested that one or the other of Figs. 217 or 238 might be omitted as they are duplications and reference to one would be all that is necessary.

Chapter XXVI is certainly a most acceptable consideration of the subject of the medico-legal aspect of emergency surgery, malingering, the question of employers' liability, medical fees, testimony and the various related subjects.

The treatise can be heartily recommended to the practitioner who has this type of work to deal with, knowing that the subject is exhaustively and authoritatively considered by one entirely and peculiarly competent to present it in its most concise form. JAMES T. PILCHER.

A CLASSIFICATION OF THE TUMORS OF THE GLIOMA GROUP ON A HISTOGENETIC BASIS WITH A CORRELATED STUDY OF PROGNOSIS. By PERCIVAL BAILEY, M.D., and HARVEY CUSHING, M.D. Octavo, cloth, pp. 75. J. B. Lippincott Co.

Tumors of the glioma group represent about forty per cent. of all intracranial neoplasms. This subject is a comparatively new field for exploration,

but insofar as it is complete, so have the authors made this book. As a result of investigations begun some years ago, and from records of over four hundred "verified gliomas," questions on the clinical significance of their histological variation, on the basis of the structural variability shown by these gliomatic tumors, and on prognosis are satisfactorily answered. We would suggest that the neurosurgeon desirous of attaining the most from this volume have his mind in as sharp a condition as he would his finest surgical instrument; this is not a book to be enjoyed by anyone except one who is keenly interested in this particular subject; others might read for an hour and close the book and know not of what they have read.

FREDERIC C. EASTMAN.

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